Vol. XLIX **TABLE OF CONTENTS.** No. 8

(20 pages; no inset.)

Page

ENGINEERING NEWS OF THE WEEK..... 165, 183

LEADING ARTICLES:
Methods of Work Adopted in Constructing the Chicago Telephone Tunnels (illustrated).. 166
Gift Propositions for Paying Workmen.....Frank Richards, M. Am. Soc. C. E. 168
Royal Commission Studies on Pollution and Self-Purification of the River Severn. (illustrated). 170
Electric Pumping Plant at the Bridgeport Station, Chicago, for the Illinois & Michigan Canal (illustrated)..... 172
Notes from the Engineering Schools..... 173
A Concrete-Steel Pile Foundation (illustrated)..... 173
A Joint for Galvanized Steel Pipe (illustrated)..... 178
Electricity vs. the Locomotive for Trunk Line Railway Service.....C. F. Sweigert. 179
The Great Magnetite Deposits of Sweden..... 179
The Schwarz Drying and Mixing Machine for Manufacturing Lime-Sand Brick (illustrated) 179
An Official Recommendation of Automatic Stops in Connection with Block Signals..... 180
The Coroner's Verdict on the Westfield Collision..... 180
The New York Rapid Transit Railway. XVII. Contract Section XII. (illustrated)..... 181
A New Westinghouse Horizontal Gas Engine..... 183
Cost of Diamond Drilling in Natal..... 183
The New Plans for the Manhattan Bridge Across the East River at New York City. (illustrated). 183

EDITORIAL COMMENT.—The Accident in the Cascade Tunnel of the Great Northern Ry.—A Proposed Railway Commission for New York City—The Premium Plan of Paying for Labor Viewed from the Workman's Standpoint—The Municipal Explosives Commission of New York City and its Refusal to Investigate Safety Explosives..... 174

EDITORIAL.—Automatic Stop Adjuncts to the Block Signal System..... 174

LETTERS TO THE EDITOR.—The Effect of Manure on Concrete: John Algie—The Failure and Repair of the Bottom of a Wood-Stave Tank: John Lathrop Gray—The Discipline of Locomotive Runners in the Observance of Signals: John C. Chase—Block Signals on the Philadelphia & Reading R. R. and Why Engineer Davis Failed to Obey Them: H. D. F.—An Analytical Method of Determining Illumination (illustrated); Van Rensselaer Lansingh—The Difficulties of Transition from the Present System to the Metric System: B. Schreiner—The Metric System on Railway Construction Work in Mexico: A. S. Robinson—The Metric System in Railway Work: Caspar Wistar Haines—The Metric System; A Big Job for a Literary Engineer: M. Am. Soc. M. E.—Notes and Queries..... 175, 178

THE STEAMSHIP "CEDRIC," of the White Star Line, now on her way across the Atlantic to New York, is the largest vessel afloat. The "Cedric" has a gross tonnage of 21,000 tons, and a displacement of 38,000 tons. She is 700 ft. long, 75 ft. wide and 49 ft. 4 ins. deep, and is driven by twin screws. Her designed speed is 17 knots.

A BRIDGE CROSSING LONG ISLAND SOUND between Port Morris, N. Y., and Astoria, Long Island, is planned by the Pennsylvania R. R. to give connection between its Long Island system and the railway lines reaching the New England states. According to the published statements the bridge will start at Port Morris and cross Randall's Island and Ward's Island and the Hell Gate Channel to Astoria. The span across Hell Gate will be 840 ft., and the total length of the bridge will be about two miles. The bridge will, it is stated, cost about $10,000,000, and it is further stated that the contract for the steel has been awarded.

THE HIGH-SPEED STEAM RAILWAY COMPETITION of the German Society of Mechanical Engineers, announced about a year ago and closed on Jan. 1, 1903, resulted in no prizes being awarded. Instead, five of the plans submitted were given honorable mention and were awarded a bonus of 1,000 marks each. The authors of these five plans were: Mr. R. Avenmarg, of Munich; Mr. M. Kuhn, of Kassel; Prof. von Borries, of Berlin; Mr. H. Mehlis, of Berlin, and Mr. Peglow, of Berlin. Thirteen plans in all were submitted, of which only four covered both locomotives and cars. It is now proposed to institute a closed competition, between the five above-mentioned engineers, on the basis of new specifications. The competition just ended called for steam locomotives suited to haul passenger trains at a speed of 90 miles per hour, and for passenger cars and equipment suited for operation at this speed. The purpose of the competition is not quite clear, inasmuch as it has been long demonstrated, particularly by American practice, that the obstacle in the way of high speed operation was the track, and not the motive power; the same thing was also shown by the electric high-speed trials on the Berlin-Zossen line. It seems likely that the competition was intended as a sort of counterbalance to these trials in their effect upon engineering opinion.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Southern Ry., near Alexandria, Va., on Feb. 15, shortly after midnight. A fast through passenger train was derailed by an open switch, and the engineer and the fireman were killed in the wreck. It is believed that the switch had been maliciously opened, the lock and the signal lamp being removed.——A landslide wrecked a train on the Baltimore & Ohio R. R. near West Newton, Pa., on Feb. 10. The bank of a deep cut slid down upon a freight train and caused the death of the fireman.

A TRAIN STALLED IN A TUNNEL nearly caused the death of everyone on board a week ago. The Cascade tunnel on the Great Northern Ry., near Wellington, Wash., is 13,283 ft. long ,and rises eastward on a 1.7% grade; helping engines are required to draw eastbound trains up the grade of the tunnel and of its approaches. An eastbound passenger train nearing this tunnel took on, in place of the regular helper, a large freight engine, which was coupled on at the head of the train. Before the tunnel was reached the coupling between the two engines gave trouble by pulling out several times. This repeated itself in the tunnel, and each time the train had to stop while the coupling was being repaired. Three such stops in the tunnel filled the latter with the smoke and gases from the two engines to such an extent that it was not considered safe to go ahead and risk being stalled again. The train crew, after a consultation, decided to send the helper on ahead to Cascade Tunnel Station, so that another engine could be sent to help the train through. Shortly after the helper had left, however, the conductor realized that the condition of the air in the tunnel made it imperative to get the train out of the tunnel at once, and the only thing possible was to back out down grade. Going forward he found the engine crew already unconscious, and was himself overcome almost immediately. The same thing befell the head brakeman. It happened that a fireman of the road, one Abbott, was on the train, and he now took it upon himself to get the train out. He got to the engine, released the air brakes, and started the train back down grade without being overcome. At Wellington station another engine was secured and the tunnel was passed without further accident. Most of the passengers on the train had become seriously affected by the gases when Abbott backed the train out, and several of them were unconscious. Three of the trainmen were sent to the hospital when Wellington was reached.

DAMAGES FOR INJURIES BY A THIRD RAIL to the amount of $12,000 were awarded at Springfield, Mass., on Feb. 16, in a suit brought by four residents of New Britain, Conn., against the New York, New Haven & Hartford R. R. Co. The plaintiffs were injured at a crossing in Forestville, Conn.

THE STORAGE BATTERY STREET CARS operated on the 34th St. crosstown line in New York city have given rise to renewed complaints. Nearly a year ago there was serious complaint on the part of the public against the acid fumes noticeable in these cars, and the Department of Health finally compelled the company to install ventilating devices which would ensure that the air in the cars would be kept free from the fumes. It now seems that these devices are practically inoperative, and the matter is again before the Department of Health. It is probable that the line will be ultimately converted into a conduit line like the other electric street railway lines in Manhattan borough of the city of New York.

POLLUTED WATER at Noblesville and at Michigan City, Ind., it is supposed, has been the cause of much sickness at those places this winter. At our request the following statement has been sent to this journal by Dr. J. N. Hurty, Secretary of the Indiana Board of Health:

About Jan. 30, 1903, a peculiar taste was noted in the water supply of Noblesville. The water supply comes from wells which are on the bank of the river. They, of course, receive considerable filtered river water. In a few days cases of diarrhœa commenced to appear. In all there have been about 800 cases. Some of the doctors called the disease "winter cholera."

Pretty nearly the same experience has occurred in the last week at Michigan City. One year ago this winter they had an awful time at the last-named place. They have there two intakes, one opening into the lake and the other into the harbor. The harbor receives the sewage of the city. The object of the two intakes is because if "needle-ice" forms it will stop the pipe from the lake, and that would leave the town without water. A year ago the pumps commenced to labor and the engineer immediately opened the valve of the intake from the harbor. In 24 to 48 hours, there were 2,000 cases of diarrhœa. Almost the same experience has been repeated this winter. It is indeed strange that people will not learn, but learning is a slow process.

It is reported that a break in the water main allowed the river water to mix with the supply.

AN EPIDEMIC OF TYPHOID FEVER at Ithaca, N. Y., is attributed to the water drawn from Buttermilk Creek, one of the two sources of supply of the Ithaca Water-Works Co. Several hundred cases of sickness had been reported up to Feb. 14, of which it appears that nearly 200 were typhoid fever. The independent supply for the buildings on the campus of Cornell University appears to have been unaffected, particularly as some 300 young women in a dormitory there escaped the disease, while many of the men students rooming about the city were attacked. At the latest reports a movement, headed by President Schurman, was on foot to secure the adoption of filtration by the water company.

WASHING OUT OF THE FALSEWORK wrecked one of the incompleted spans of the new 14th St. steel highway bridge, which is being built across the Chattahoochee River, at Columbus, Ga., on the night of Feb. 7. The bridge consists of five equal spans, 140 ft. 10½ ins. long, and having a clear roadway width of 26 ft., with two outside sidewalks, on brackets. There is one line of electric street car track located in the roadway. The substructure consists of two abutments and four piers, all built entirely of concrete. At the time of the accident (about 11 o'clock at night) two of the five spans were erected and swung, and the falsework had been removed. The third span, the one that was lost, was all assembled and in place, excepting one end panel, and would have been connected and safe in about one more day; consequently nearly the entire span was lost, excepting some of the stringers and lateral members. The two spans which were bolted up, and the substructure was not damaged at all. The total rise in the river at the bridge was about 15 ft., 12 ft. of which occurred in the 24 hours immediately preceding the failure. The rainfall at Columbus, as reported by the government observer, was 3.25 ins. for the 24 hours, ending on the morning of the 8th. The superstructure of the bridge is being built and erected by the American Bridge Co.; the erection being done by Messrs. Geo. H. Crafts & Co., of Atlanta, Ga., under a subcontract with the bridge company. The substructure was built, under a separate contract, by Mr. B. H. Hardaway, of Columbus, Ga. It will be possible to recover nearly, if not all, of the steel, but to what extent it is damaged cannot now be ascertained.

CIVIL SERVICE EXAMINATIONS beginning April 21, and lasting two days, will be held in all the larger cities in the United States, to fill the positions of assistant topographer and topographic aid in the United States Geological Survey, and positions in other bureaus of the government doing kindred work. The subjects of the examinations with their weights will be as follows:

Mathematics; including algebra, geometry, trigonometry, logarithms, mensuration and projections..... .20
Surveying; use of instruments and elements of astronomy as applied to surveying, these questions being arranged to show practical methods of field work and not theoretical or mathematical knowledge ..... .20
Contour construction, topographic drawing and lettering; the latter to be executed subsequent to the examination and mailed to the Commission..... .30
Educational training and experience; to show qualifications as surveyor or engineer. ..... .30

The minimum age limit for applicants is 20 years. The eligibles resulting from the examination may receive appointments in the United States Geological Survey at salaries ranging from $720 to $1,200 per annum, with expenses paid in the field. The examination is open to all citizens of the United States, and competitors are rated without knowledge of their names by the numbers shown on their examination papers, and are certified strictly in accordance with civil service laws and rules. Those who pass these examinations are in immediate line of promotion to the full grade of topographer and ultimately to that of geographer and administrative chief, with salaries ranging from $1,200 to $3,500. The demand for assistant topographers is so great that all on the eligible lists for the past few years have been immediately offered employment, and promotions have been comparatively rapid, progressing at the rate of $100 to $200 per annum. Persons who desire to compete should at once apply to the United States Civil Service Commission, Washington D. C., in order that they may have a month in which to file their formal applications. In addition to the above permanent positions in the topographic branch of the United States Geological Survey, there is offered temporary employment in the early spring to such persons as have had experience in field surveying, especially in the use of level, transit, etc., or who have attended a course in engineering colleges. This temporary employment will last until late in the fall and may lead to permanent employment through a civil service examination. Pay for this work ranges from $50 to $75 per month, with field expenses added. Applicants for such places should communicate at once with the Director of the United States Geological Survey, Washington, D. C.

METHODS OF WORK ADOPTED IN CONSTRUCTING THE CHICAGO TELEPHONE TUNNELS.

A network of tunnels aggregating 60 miles in length is now being constructed under the streets of "down-town" Chicago. These tunnels are of horse-shoe section, with concrete lining and interior dimensions, of $12\frac{2}{3} \times 14$ ft. for trunk tunnels and of $6\frac{1}{2} \times 7$ ft. for lateral tunnels. The system is designed to provide underground conduits for the telephone wires of the Illinois Telephone & Telegraph Co., and about 15 miles of its total length have been completed. Some of the general details of this important undertaking have been described in Engineering News of May 2, 1901, and July 17 and Sept. 25, 1902. More recently a full description of the work has appeared in a paper read before the Western Society of Engineers by Mr. George W. Jackson, the engineer of the Illinois Telephone & Telegraph Co. This paper devotes particular attention to the plant used and methods of work adopted in constructing the tunnels, and from it and from information furnished us directly by Mr. Jackson we have prepared the following description of these special features.

Fig. 1. Map of Down-Town District of Chicago, Showing Routes of Telephone Tunnels of Illinois Telephone & Telegraph Co. George W. Jackson, Manager and Engineer.

GENERAL DESCRIPTION OF THE WORK.

The work undertaken by the Illinois Telephone & Telegraph Co. was to build a telephone system capable of accommodating 100,000 subscribers and having all its cables in underground conduits. Briefly described, a network of conduit tunnels was first to be built under the streets of the downtown or business section of the city. This conduit system was then to be extended north, west and south to the outlying districts, building tunnel so far as it was economical and laying tile conduit elsewhere. The downtown portion of the conduit system was to be built first and the north, south and west side systems afterwards.

PRELIMINARY STUDIES.—The general plan of the conduit system having been decided upon, the first task was to develop plans and methods for carrying out the first portion of the work in the downtown streets. After thoroughly canvassing the requirements of an exchange for 100,000 telephones and figuring on the space required, it was found that the space was not to be obtained immediately below the street surface owing to the great number of pipes and conduits already existing. The only resort was to build deep conduits below any of the existing structures, and after sufficient investigation had been made to assure the company that such a deep conduit system was feasible to construct, general plans were prepared and a permit to begin work was asked and secured from the city authorities. Work was at once begun under this permit, but before it had proceeded far it was found necessary to halt until an accurate map of the city streets could be prepared, since none existed. The surveys for this map were undertaken by the telephone company's engineers under the direction of Mr. Alfred Slade, and after completion were checked and approved by the Department of Public Works. The work of construction was now ready to proceed. The city authorities, upon being notified of this fact, however, informed the company that work would not be allowed to proceed under the terms of the original permit.

The reasons for this decision were that the original plan called for a series of manholes connecting the tunnels at intervals with the street surface, and that the minimum depth of 22 ft. 6 ins. below the street surface was too little. Both the manholes and the shallow depth of the work, it was considered, would be obstructions to an underground railway, which it was thought the city would some day be certain to build. As the result the company was compelled to modify its original plans, and after much study it was concluded that the manhole construction could be done away with by building large trunk conduits into which, by means of a special shaft, reels of cable could be lowered and transported on cars around to the different lateral conduits. This conclusion being arrived at, revised plans were submitted to and approved by the city authorities.

FINAL PLANS.—The final plans for the downtown district called for a system of trunk and lateral conduits arranged as shown by the map, Fig. 1. In cross-section the trunk conduits were 12 ft. 9 ins. wide and 14 ft. high, and the lateral conduits were $6\frac{1}{2}$ ft. wide and 7 ft. high. The minimum depth between the street surface and the topmost part of any of the conduit structure was set at 24 ft. 6 ins. Fig. 2 is a cross-section of one of the lateral conduits, showing the racks for the cables in place. The trunk conduits were of the same general cross-section, and had 21-in. bottoms and 18-in. sidewalls.

METHOD OF CONSTRUCTION.

The construction work to be done in building the conduits consisted of the excavation of the tunnels and the lining of this excavation with concrete.

MATERIALS PENETRATED.—The subsoil underlying the downtown streets of Chicago consists of about 10½ ft. of filling, then of 18 ins. of yellow loam carrying considerable water, then of about 5 ft. of soft clay, and then of hard clay, increasing in firmness with the depth. The conduit tunnels were entirely in the hard clay, which stood up well under excavation.

SHAFTS.—The work of construction was carried on from eight shafts located as shown by Fig. 1. All of these shafts were located in basements rented for the purpose. Fig. 3 shows the arrangement of the head plant in the basement occupied by shaft No. 1. The arrangement at other shafts, of course, differed in detail.

EXCAVATION.—The pneumatic system was adopted for carrying out the work. While it was not altogether necessary to use this system because of the nature of the soil penetrated, yet it was deemed advisable to take the precaution to do so principally as a safeguard in case of a labor strike, which would leave the work uncompleted. In installing the pneumatic system air locks were placed at the bottom of each shaft.

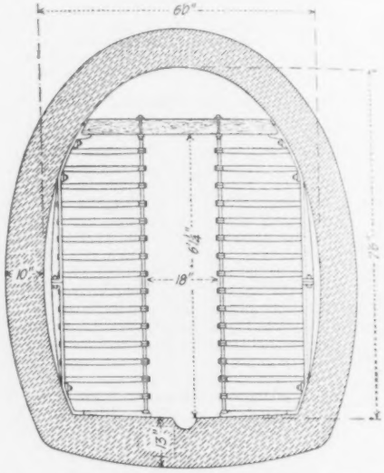


Fig. 2. Cross-Section of Lateral Conduit, Showing Racks for Cables.

These locks consisted of a chamber formed by closing off a section of tunnel by air-tight iron doors set in concrete at each end. Some of these chambers were capable of holding ten cars. The method of locking in and out was the simple operation familiar to all engineers.

The tunnel was constructed by three shifts of workmen, working 8 hrs. each. From 4 p. m. to 8 a. m., two shifts were engaged in excavation, and from 8 a. m. until such time as their work was finished one shift was engaged in constructing the lining. The distance excavated by the two shifts of miners averaged about 21 ft. in each heading of lateral tunnel. About 20 men were required to operate each heading.

DISPOSITION OF SPOIL.—In conducting the excavation, in order to have everything run smoothly, considerable care had to be exercised to see that the excavated material was promptly disposed of. The spoil was either dumped along the lake front where the new Lake Front Park is being built or was taken to the river bank and dumped into scows. Briefly described, a system of spoil tracks was laid on the tunnel bottom from each shaft to the headings being worked from that shaft. Cars from the headings were run to the shaft on these tracks and then hoisted to the surface by elevators. At all the shafts but one the shaft elevators were raised either to the second floor of the building above the basement occupied or else to a corresponding level in a shaft head-house built on the curb line as shown by Fig. 4. Here the cars were dumped by means of suitable chutes into wagons, which conveyed the spoil to the lake front. At the lake front a stiff-leg derrick was installed, and as each wagon arrived, this derrick was used first to lift away the side boards of the wagon and then to hoist the

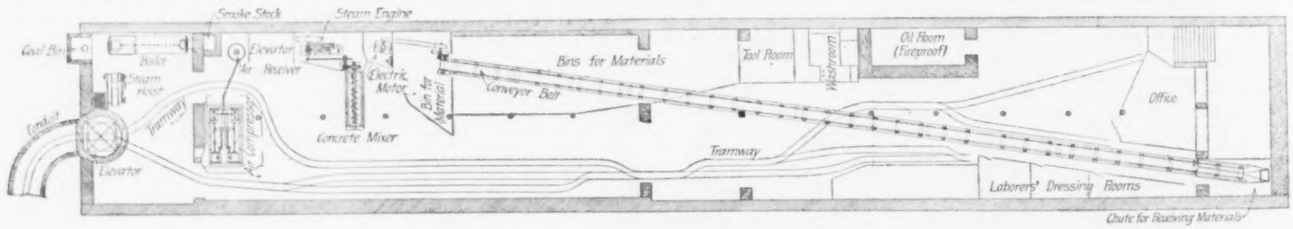


FIG. 3. GENERAL PLAN OF PLANT AT SHAFT NO. 1.

wagon body and dump its load. The excavation being done during the late afternoon and night shifts, it was possible to haul away most of the spoil between 5 p. m. and 7 a. m., when other street traffic was at the minimum.

At shaft No. 8, the exception noted above, a different method of handling the spoil was employed. This shaft was located close to the bank of the Chicago River, at the south end of Market St., where, also, the company's warehouse is located. Here an incline was constructed from the tunnel to the street surface, up which the cars were hauled by an endless chain with dogs which took hold of the axles. They were then run onto a fan-shaped system of tracks leading to dumping platforms. These platforms were hinged to the edge of the wharf and provided with gallows frames by which they could be raised and lowered. When lowered they overhung a scow moored alongside the wharf, and when raised they left the channel clear. Fig. 5 shows these dumping platforms with a partly-loaded scow in place. This method of handling material was found to be very economical and convenient.

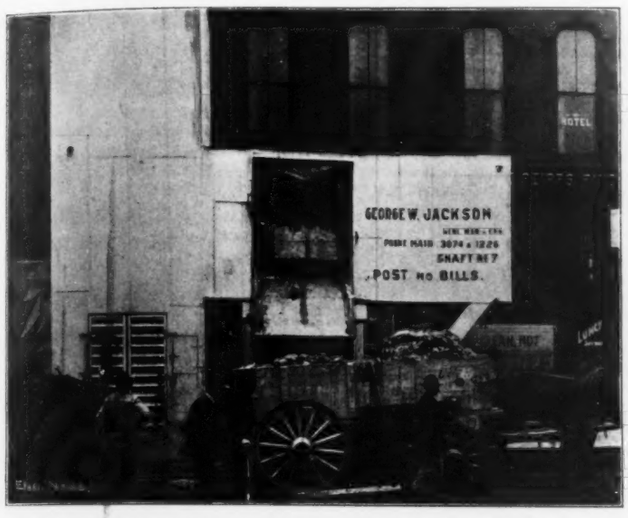


FIG. 4. VIEW OF SHAFT HEAD HOUSE, BUILT ON CURB LINE.

FIG. 5. VIEW SHOWING MOVABLE PLATFORMS FOR LOADING SPOIL SCOWS ON RIVER FRONT.

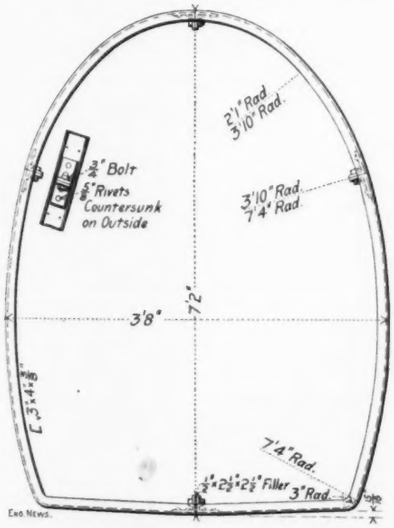


Fig. 6. Frame and Form for Lagging for Lining Lateral Conduits.

The cars used in handling the spoil to the shafts and taking the lining concrete from the shafts to the work, were 20 ins. wide and 4 ft. long, and were built to run on a 14-in. gage track. Mr. Jackson remarks concerning the small size of these cars, that this was in his opinion largely instrumental in the success and rapidity of the work. One reason for this was that if a car jumped the track it could be set back by hand and by one man. Another advantage was that each car load of concrete could be so speedily handled as to prevent initial set before the material was deposited in the lining. Altogether 900 of these cars were built and used.

LINING CONSTRUCTION.—The construction of the concrete lining followed the excavation closely, the two excavating shifts in each heading being followed by a lining shift, so that excavation and lining proceeded alternately in each heading. The lining consisted of straight line work, and of two, three and four-way intersections. Concrete was used entirely. For the straight line work the concrete was composed of one part American Portland cement and five parts of broken stone and screenings, or five parts of mixed gravel and sand. For the intersections the proportion of aggregates was reduced to four parts. All the cement was carefully tested before use, a sample being taken from every barrel. The concrete was all mixed in the basements occupied by the shafts, and then taken to the work in the small cars previously described.

In constructing the lining the floor was first laid; rib centers were then set up on the completed floor and lagged for the construction of the sidewalls and roof. The lagging was placed beginning at the bottom on each side and built up as fast as the concrete could be placed and tamped behind it. When the crown of the arch was reached short sections of lagging 3 ft. long, extending over two ribs, were placed and the concrete was filled in from the end and tamped in place. In all cases the lining concrete was made to fill completely the space between the lagging and the encircling walls of the excavation.

Two forms of center ribs and lagging were employed, one for the lateral conduits and one for the trunk conduits. For the lateral conduits the ribs were made of 3-in. channels curved to the sectional profile of the conduit. One of these ribs is shown by Fig. 6. As will be seen, each rib is composed of four segments joined by riveting short flange bars to the inside of the channel and bolting their projecting flanges together. These ribs were set 3 ft. apart and the lagging used was 2-in. plank.

The ribs used for the trunk conduits were much similar to those for the lateral conduits, except that they were thoroughly braced, as shown by the general elevation of Fig. 7. The rib channels were 5-in., 6½-lb., steel channels and 4 × 4 × 5-16-in. angles were used for bracing. The ribs were made up of sections bolted together. In place of wooden plank, however, a steel lagging consisting of plates stiffened on all four edges by angles, as shown by Fig. 8, was employed. Furthermore, to permit the end of each section of lining to be finished off square and thoroughly tamped, vertical diaphragm plates or "end flights" were attached to the end frame, as shown in elevation by Fig. 7 and in detail by Fig. 9.

For the three and four-way intersections special forms of ribs had to be provided; they were, however, of similar construction to the ribs described above. Fig. 10 shows in plan the arrangement of the center ribs for a three-way intersection, and Fig. 11 is a similar illustration for a four-way intersection. These plans also furnish a clear idea of the construction of these intersections. A view of a completed four-way intersection is given in Fig. 12, and presents, as will be seen, a handsome piece of concrete masonry work. Fig. 13 is a view of a lateral conduit under construction, showing the centering, the front end of the concrete lining with the key section ready to be filled in at the crown, and the excavation ahead of the lining. The nature of the material penetrated is excellently illustrated by this view.

PROGRESS OF WORK.—On Sept. 1, 1902, there had been completed 59,954.57 ft. of straight lateral conduit, seven two-way intersections, 29 three-way intersections, and 25 four-way intersections, making altogether 61,726 ft. of conduit. This conduit was completed in 10½ months of actual work. The work done and the rate of progress at each shaft during this time was as follows:

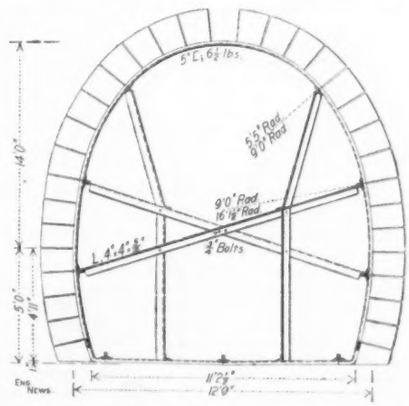


Fig. 7. Frame and Form for Lagging for Lining Trunk Conduits.

		No. ft.	Working days.	Average per work'g day.
Shaft	No. 1	18,730	294	63.1 ft.
"	" 2	14,595	247	59.2 "
"	" 3	2,464	118	20.5 "
"	" 4	17,510	229	76.1 "
"	" 7	1,244	63	19.4 "
"	" 8	7,183	176	40.1 "

The average working days from all shafts were 188, the average daily progress from all shafts was 328 ft., and the total excavation from all

shafts was 175,000 cu. yds. The amounts of concrete materials used in this work were: Cement,

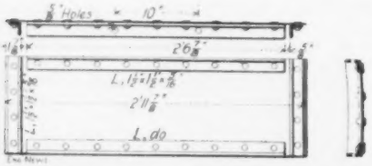


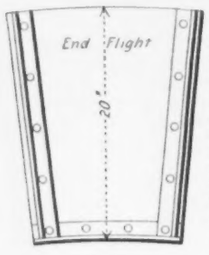
Fig. 8. Details of Steel Lagging for Lining Trunk Conduits.

90,000 barrels; broken stone, 30,000 cu. yds.; and gravel, 60,000 cu. yds.

GIFT PROPOSITIONS FOR PAYING WORKMEN.*

By Frank Richards, M. Am. Soc. M. E.†

They are most fortunate evermore who can work most wholeheartedly. The wage earners of the world have not hitherto been thus fortunate, and they and the world have been the losers. They certainly have not been so situated hitherto that they could have any desire to do what they could to its utmost, and still less to seek for ways of doing still better. They certainly have a right where possible to more operative and unfailing incentives. How to change the worker's attitude toward his work by means of a change in the system of apportioning the recompense for it would seem to be the foremost problem of the opening years of the new century. How shall the worker, whatever his grade of skill or efficiency, who has hitherto worked only for a fixed daily wage, be so paid hereafter that he shall not only get all that he earns, but that he shall be willing and even desirous to do more, and thus to earn more, up to the limit of his ability? We have done much boasting, especially as Americans, over the excellence of our machines and over the continuing increases in their efficiencies. Why have we not been equally exultant over the individual efficiencies of our men, and equally diligent and successful in promoting their efficiencies? It is notorious and it is absurd that it should be so, that the worker finds little satisfaction in his increasing output, and that he takes



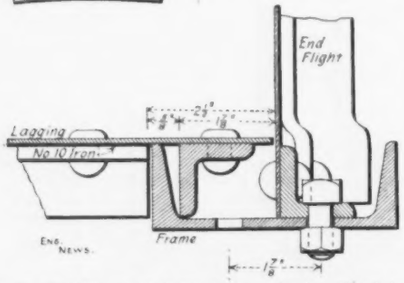


Fig. 9. Details of End Diaphragm Plates Used in Lining Trunk Conduits.

no pride in it, but rather organizes to retard it as much as he can.

The reason seems to be plain enough. Daily wages, and the same wages for each, offer nothing at all to induce one man to do more than another. Why should any man who works for so much a day try to do more than just what will hold his job? Indeed, according to prevalent modes of reasoning, if he does more without commensurate remuneration, what is he but a fool? In spite of all efforts at equalization there is always an appreciable and often a very great difference in the quality or quantity of work done by different men; and if all are paid alike, then either some are not paid enough or some are paid too much, and pay by the day would never seem to be fair and just to all. The system survives, we may believe, chiefly because nothing better and generally applicable has been devised.

Other schemes are, of course, continually being tried, and even adopted, more or less extensively. On the face of it, piece work, or pay exactly proportioned to the amount of work done, is the only exact justice. Unfortunately, it is sometimes so craftily manipulated that justice deserts it. On the promise of equitable payment for actual work, and in exact proportion to what is done, the worker claims too often to find that in the end it is a mere arrangement to squeeze from him more work for less wages, so that if by day wages some are paid too little, by piece work a much greater number are ultimately so paid.

This estimate of any system which has the name of piecework is quite widely held by wage-earners. The essential justice of the piece-work system remains, and it might be well worth while to investigate the mistakes, and worse, which have misdirected its application. Instead of that, we have set to work to devise other schemes. We have now before us, skilfully stated and earnestly advocated, the "Bonus System of Rewarding Labor"† and the "Premium Plan of Paying for Labor."* The essential error in both of these would seem to be in the ignoring of the strictly business relation of employer and employee. The employer of any worker is simply a buyer of what the worker has to sell, ostensibly paying equitably for what is done and for all that is done. Why, if possible, should he not pay in exact proportion to the quantity done, the same as in buying coal or beef or any other merchantable commodity? If the gift proposition is all right in paying the workmen, why not propose also a Bonus System of Rewarding the Grocer or a Premium Plan of Paying for Beef?

Of the two devices here spoken of together, the premium plan seems to be the most prominent and to be regarded with the greatest favor. I know that the plan has been devised and proposed in all honesty, and with the most commendable of intentions, and that it has been advocated and promoted by its originator as the fairest thing at present possible between employer and employee, and at the same time an ideal stimulant for the worker; nevertheless, it is for be to speak of it only as I see it.

It happens that I am familiar most of all with the things which pertain to machine shops, and with the ways in which things are done in machine shops, including the adjustment, and the various attempts at adjustment, of the pay to suit the work. It happens, also, that the so-called "premium" plan has had its trial and adoption, and what successes it has won, chiefly if not entirely in the machine shop. We will go right into the shop, then, and try to understand the plan and how it works, especially in comparison with the regular old daily wage system.

We assume, which it is easy enough now to do, that times are good, that the men have constant work and fair daily wages, and that the employer is finding profit in his business. In the shop are two workmen, each running a lathe, the lathes precisely alike, and each turning out the same amount of work every day. Each lathe is worth, as it stands with all its tools and appurtenances, say, $1,000. The proportion of value of the buildings and other details of the general plant chargeable to the individual lathe is, say, as much more. This makes $2,000 as the actual capital that it is necessary for us to consider in this relation. We allow, say, 10% per year on this value to cover interest, repairs, maintenance, and depreciation; which is $200 per year, or, say, 65 cts. per working day. We will allow for the power to drive the lathe, oil for its lubrication, waste to wipe it, and all that, 35 cts. a day. Then there is a share of the office expenses—"non-productive labor," as they call it—and all the other things that it takes to keep the business going; this we may put at 50 cts. per day. We will pay each man $3 per day, and then the total daily charge for each lathe will be like this:

Interest(etc., on lathe and plant.	$0.65
Power and operating expenses	.35
Office expenses	.50
Man's wages	3.00
Total cost per day	$4.50

It makes no difference for our present purpose whether these figures are all just and proper or not. Anyone may assume any other figures to suit his taste.

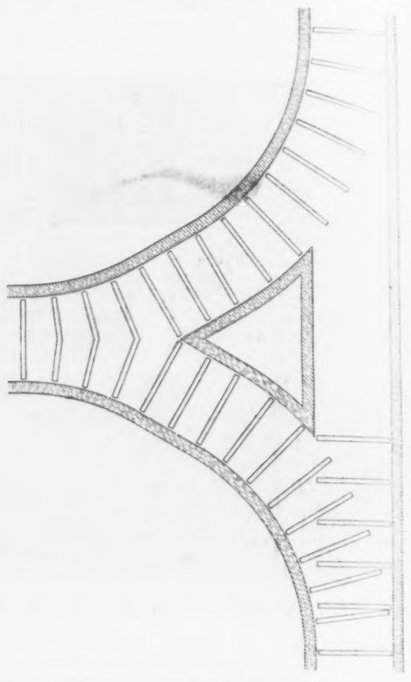


Fig. 10. Plan of Three-Way Intersection, Showing Arrangement of Center Frames.

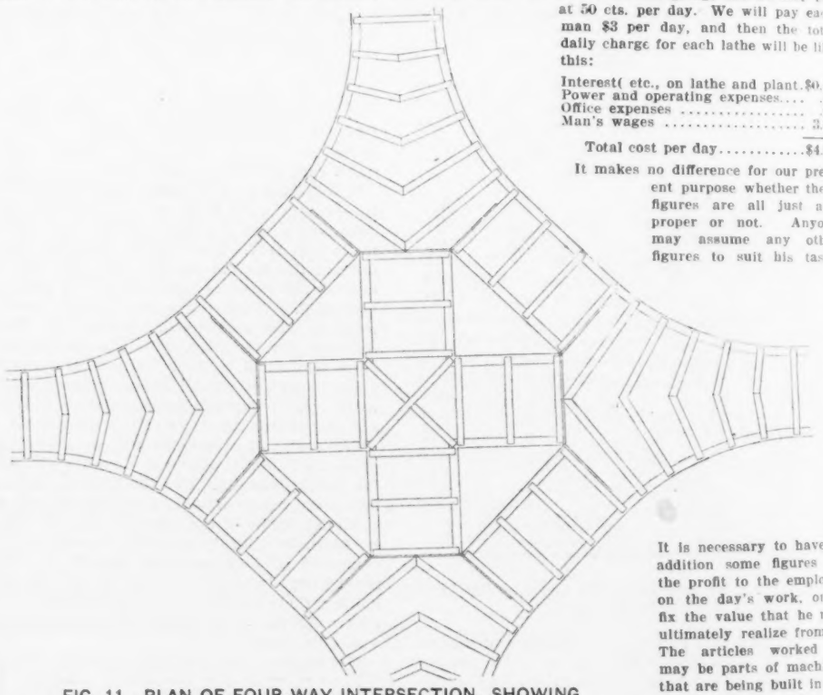


FIG. 11. PLAN OF FOUR-WAY INTERSECTION, SHOWING ARRANGEMENT OF CENTER FRAMES.

It is necessary to have in addition some figures for the profit to the employer on the day's work, or to fix the value that he may ultimately realize from it. The articles worked on may be parts of machines that are being built in the shop, or they may have to go through subsequent operations that will add to their ultimate cost, but we here assume a value for the work as it leaves the lathe, and which may be realized for that part of the work which is done on the lathe. We will add, say, one-third, or $1.50, for the proprietor's profit, which will make the total value of the day's work of one lathe $6, and of the two lathes $12. We are to remember, then, that, as things are going by regular day work, the proprietor's daily profit for each lathe is $1.50 and that each man's wage for the day is $3.

The work of each lathe, with the men thus working by

*A paper presented at the New York meeting of the American Society of Mechanical Engineers. See also papers by F. W. Taylor in Engineering News, Vol. July-Dec., 1895, p. 3; and by F. A. Halsey in Engineering News, Vol. July-Dec., 1891, p. 61.

†Associate Editor "American Machinist," World Building, New York city.

† Eng. News, Vol. July-Dec., 1895, pp. 3, 8.

* Eng. News, Vol. July-Dec., 1891, p. 61.

the day, is, say, the boring and turning of ten wheels of a special style for each day's work. Now it so happens that, to keep up with his business, the proprietor needs more wheels than the two lathes are turning out, so he puts in another lathe and employs another man, and when he gets it going it turns out precisely the same amount of work as the others, and the boss and the men are all satisfied. The proprietor's share or profit on the work of the three lathes is $4.50 per day, and the sum

FIG. 12. VIEW OF FOUR-WAY INTERSECTION COMPLETED.

of the wages of the three men is $9 per day. There is and can be no pretence or suggestion that the third man does not earn his wages as fully as the other two. The idea thus far is the accomplishment of so much work for so much pay, no matter who does it. Each man doing his ten wheels a day is paid as much for the second five of them as for the first five, and the proprietor gets the same profit out of the last five as out of the first five.

With things going along thus satisfactorily, what if a man should take a spurt, and by persistent watchfulness of the speeds and feeds of the lathe, by keeping every cutting tool constantly ready and always at its sharpest, and by celerity and precision in making his changes of work and all the necessary adjustments, he should turn out five more wheels per day? Shoulde he not receive for the third five as much as for the first five or the second five, as long as he had been only equitably paid before?

In work that is paid for by day wages there is always this recognized ability in the man to somewhat increase his output if sufficient inducement is offered. There is a "fair day's work" that is recognized as such and accepted as satisfactory all around, and yet which is never assumed to be the extreme limit of a man's possible accomplishment. There are different ways of applying inducements to the men to get them to turn out the possible surplus of work. The proprietor should have no difficulty in recognizing the justice and propriety of paying pro rata for all the work turned out, *as he certainly is paid in that way for all the product of his shop.*

Returning now to the two men jogging comfortably along and turning out each his ten wheels a day and getting his $3. The boss to poke them up can simply tell them that he will pay them at the same rate for all they can do. It may then happen that when the men get everything tuned up and have acquired their full momentum they will actually turn out fifteen wheels a day each, and each get his $4.50. Besides the additional wages paid to the men there will be no increased expense to the proprietor, except possibly one or two cents a day for additional power consumed, an item undiscoverable in practice and entirely negligible here. With the three men on the three lathes turning out each his ten wheels a day the men each received $3, or $9 in all, and the proprietor received $1.50 net profit for each man's day's work, or $4.50 in all. Now, with two men doing the same work, although the proprietor has paid in wages to the two men precisely what he paid the three men, he has saved the shop room and the cost of carrying the third lathe. He has saved, in fact, the first three items of expenses as we first enumerated them for one lathe. For the two lathes turning out thirty wheels a day the cost will be:

Interest, etc., on two lathes and plant	$1.30
Power and operating expenses	.70
Office expenses	1.00
Paid two men	9.00
Total cost per day	$12.00

The value of the work turned out is, as before, $6 for each ten wheels, or $18 for the thirty wheels, so that the proprietor, although he pays the two men the same amount he paid the three men, actually gets $1.50 more profit, or 33⅓% more.

This might have been done also as a straight piece-work proposition. The proprietor might have said to the men: "Here, you fellows are working all right, of course. I couldn't get any other fellows to do any better work than you are doing, and I haven't a word of fault to find; but, all the same, you know, I'm mighty anxious to get out some more of those wheels. Let's see. You are turning out ten wheels a day; that's thirty cents apiece. Well, I'll give you thirty cents apiece for all the wheels you can turn out; so pitch in, and the more you make the more I'll make, and the better we'll be pleased all 'round." Then, when the men get to turning out their fifteen wheels a day each, the figures will be the same as those last given. Too many bosses get alarmed as soon as the men by piece-work begin to get any appreciable percentage above day wages, and then the cutting of prices begins, and the men soon get disgusted.

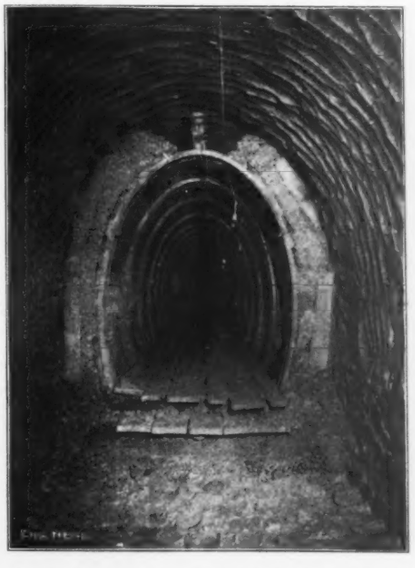


Fig. 13. View of Lateral Conduit Under Construction.

Now, it's so much better to begin right with the men. The "premium" plan is to be admired for the sweetness of its approach and its avoidance of anything but pleasant suggestions. Imagine the two men working along by the day as before, with the boss as anxious as before to increase his output, but with the "premium" plan in his head. He comes along in his cheerfulest mood and begins to talk it up. He begins to tell how he's got to get out more wheels. "Now, boys," he says, "I know you won't object to raking in a little more cash every Saturday night, and I can put in in your way. I'll tell you what I'll do. I'll go halves with you; and if anything can be fairer than that I'd like to know it. Of course, you are both turning out a fair day's work, but I suppose you could get out a little more if you looked after everything sharp. You shan't run a bit of risk of losing anything. You shall have your full day's pay for the ten wheels you turn out, just the same as now, and for all you turn out over and above the ten you shall have half of what they come to at the same rate. That's the premium plan that they are working on in a good many shops now, and lots of fellows are getting extra pay by it, and the extra pay is just as good for you as for the rest of 'em, and I'll be just as glad to see you get it."

Well, the two men go to work under this "premium" plan, and when they are under full headway, turning out fifteen wheels a day each, the statement for the two men will be like this:

Interest on lathe and plant	$1.30
Power and operating expenses	.70
Office expenses	1.00
Day wages for 20 wheels	6.00
10 wheels at .30 × 2	1.50
Total cost per day	$10.50

For the thirty wheels turned out, as before, the men each receive $3.75, or the two receive $7.50 instead of $9, and the proprietor's profit is increased by the difference, $1.50. The men get $1.50 less and the proprietor gets $1.50 more than by piece-work, every circumstance being identical in the two cases, except that in the latter the men have worked under the "premium" plan. It requires no further demonstration to convince anyone that the plan carries a premium, but take notice who it is that gets the premium; and he who gets the premium should, of course, praise the plan. Those who are getting the premium are the ones to-day praising the plan.

I believe I have not here stated the premium plan unfairly, or misrepresented the mode of its presentation by the employer to the workmen. It seems to be proper to ask, as man speaking to man, is this premium plan such as any square-dealing business man would propose to another, or is it what a sharper would propose to a simpleton? Are the exigencies of business such as to necessitate and justify any and every device for wheedling from the workmen as much work for as little wage as possible?

One detail of the premium plan which is specially insisted upon by the promoters of it is that it shall be honestly administered, and that no advantage—no additional advantage, we might say—shall be taken of the men after it is put into operation, or, in other words, that there shall be no cutting of the rates after they have been once agreed upon. According to the illustration which I have here worked up there would seem to be little need of cutting the rates. Should the opportunity appear and the temptation arise, however, to cut the rates, there is nothing to prevent it with the premium plan any more than with pure piece-work, and either system is dependent upon the good faith of the employer. When the premium plan is put into practical operation the proposition to the men seldom is to give them more than one-half the price, as I have above assumed, for the excess of work produced. The author of the premium plan has said that he favors the giving to the men of one-third, and that he considers an offer of one-half to be dangerous, the danger consisting in the increasing temptation to the employer to cut the rate.

If, in the above, I have in any way misrepresented the premium plan, as I certainly have intended not to do, I will be glad to be corrected. I do not see that the "bonus system" differs from the "premium plan" except in the details of the device by which the same result is attempted to be secured, and it is not necessary here to consider it.

It is my view that for everything a workman can do there is a fair and equitable price, whatever the difficulty of determining that price, and that when the man does the work he should get the price. The piece which by extra exertion he does last, brings as much (or, as I have shown, more) profit to the proprietor as the first piece that is done, and it does not appear why the man should not have his pay the same for each. No one can assert that the premium plan gives him this. It does not appear to me that the premium plan, or any other gift proposition, offers or suggests a permanent or satisfactory solution of the problem of equitably adjusting the wage to the work, so that the opening century still has a job before it to devise some scheme more equitable and more deserving of permanent adoption.

EXPORTS OF IRON AND STEEL MANFACTURES for the calendar years of 1901 and 1902 are given as follows by the Treasury Bureau of Statistics:

Years.	Pig iron Produced. Tons.	Imports of Iron and Steel mfrs.	Exports of Iron and Steel mfrs.
1901	15,878,354	$20,394,995	$102,539,797
1902	17,821,307	41,468,826	97,892,036

ROYAL COMMISSION STUDIES ON POLLUTION AND SELF-PURIFICATION OF THE RIVER SEVERN.

Some unusually interesting studies of river pollution are presented by (1) Prof. R. Boyce and Drs. MacConkey, Grünbaum and Hill, and (2) by Mr. Colin C. Frye, in the second report of the Royal Commission on Sewage Disposal, recently published in England.* The first of these studies, written by Professor Boyce, covers all but the chemical phases of the subject, while the second study, by Mr. Frye, relates to the chemical side of the self-purification of the river in question.

Believing that "definite bacteriological data based upon the most recent methods of measuring intestinal pollution were wanting" it was determined to take up such phases of water pollution as the life history of intestinal bacteria after being discharged into a river; the distance below sewer outlets before it becomes safe to drink the river water, and the best means of detecting such bacteria in river water.

The first plan was to select a river into which the effluent from biological filters is discharged, but no suitable locality for that purpose could be found. The River Severn at and near Shrewsbury was finally chosen, because it was near the control laboratories of Liverpool; was used for drinking and other domestic purposes, as well as fishing; its volume and velocity could be readily determined; the stream was so tortuous that long water distances could be covered by short land journeys (see Fig. 1 for a portion of the river); it received the sewage of Shrewsbury; and certain unpolluted streams of the same drainage area had already been studied.

The investigations covered 26 miles of river, beginning two miles above the Shrewsbury waterworks intake. The river varies much in width, but averages about 200 ft. In its broadest and shallowest parts navigation in a small boat was, in dry weather, quite difficult. From November 10, 1899, to March 27, 1901, the river elevations at one of the ferries have varied by a net depth of 9 ft. 3 ins. The velocity at another ferry was 30 ft. per minute and the flow about 130,000,000 U. S. gallons per day, on July 12, 1900; on January 6, 1901, the corresponding figures were 180 ft., and 1,265,000,000 gallons. The minimum recorded flow (February, 1898) was 102,000,000 U. S. gallons per day.

The tributary streams, in the stretch under consideration, are few and with the exception of one "very dirty" brook, "comparatively clean." There are numerous land drain outlets on each side of the river. The banks of the river, except for stretches in Shrewsbury, "are for the most part composed of mud in which willows are numerous." In Shrewsbury "dust-bin rubbish" has been dumped along portions of the banks. The bed of the stream, in the town, is composed of sludge in places, but above and below Shrewsbury the bottom is rocky and gravelly. The rock bottom affords a foothold to extensive growths of Water Ranunculus.

The water-works intake is at the edge of the town,† and a few hundred yards below it sewer outfalls begin to appear, there being one large one and some 35 small ones. Two miles above the water-works intake a sewer discharges into the river the sewage from a county asylum, and probably from some houses. This is a serious source of pollution, as was evident from floating fæces and deposits of putrefying sludge. Just above the water-works intake, drain pipes "of various kinds" from an inhabited district can be seen, and throughout the town "all kinds of garbage" are thrown into the river. Below the Shrewsbury water-works intake the stream is fairly free from pollution for some ten miles to a point where the sewage from a workhouse enters the river. Some 24 miles below the intake "a multitude of sewers and drains can be seen terminating in or near the water.

The normal dry weather flow from the Shrewsbury sewers was estimated at about 1,000,000 U. S. gallons a day in 1896, or 1% of the dry weather flow of the stream. The sewage is of a domestic character, from a population of about 29,000. An analysis of the discharge from a large sewer showed 300,000 B. coli communis per cu. cm.

The river is normally clear, but has a brown color, due to a peaty drainage area. The sewage, of course, gives rise to turbidity, as also does heavy rainfall. Turbidity from the latter source is due to "fine mud in suspension." Turbidity determinations have been made in a hand centrifuge worked 2½ minutes at about 2,000 revs. per min. They clearly show the effect of the addition of the Shrewsbury sewage, and correspond with the increase of B. coli communis due to the same cause.

BACTERIAL INVESTIGATIONS ABOVE THE MAIN SOURCES OF POLLUTION.

BACTERIAL STUDIES OF LAKE VYRNWY.—This lake is in the upper drainage area of the River Severn and both the lake and its feeders, together with "the soil of the water-shed, and the mud which settles to the bottom of the lake, are constantly under observation" by Professor Boyce, in behalf of the Liverpool water-works authorities. Waters of 38 streams entering the lake were analyzed for B. coli communis; likewise 15 samples of soil from the drainage area, and many samples of lake water during a period of three years. The feeders showed B. coli in only one instance, and at that time there was a gang of workmen in the vicinity. The soil was also free from B. coli. The organism has never been found in so little as 1 cu. cm. of water, but a few have been found in a greater volume. This we add, seems to be of little significance in view of the fact that "the average number of bacteria, as determined at different points on the surface, and at various depths in the lake, is 31 per cu. cm." Only 3 of 28 samples of the deposit at the bottom of Lake Vyrnwy showed the B. coli, and only one colony was found in each case.

BACTERIA IN LAND DRAINS NEAR SHREWSBURY.—In 12 of 17 land drains discharging into the River Severn, B. coli were absent in 1 cu. cm. samples, and when present the numbers were small. The total number of bacteria in these drains varied from 100 to 3,000 per cu. cm. One land drain, not included above, showed as many as 19,000 B. coli per cu. cm., and was found to be contaminated by the sewage of the Atcham Workhouse.

BACTERIA IN BROOKS NEAR SHREWSBURY.—Small brooks entering the river showed more bacteria than the drain water, and B. coli was usually present, the average for the latter being 24 per cu. cm.

BACTERIA IN THE RIVER SEVERN JUST ABOVE SHREWSBURY.—Samples taken during a period of a year, about 60 ft. above the county asylum sewer outfall, where serious pollution begins, showed an average of about 10,000 bacteria per cu. cm., or 5,000 if a few exceptional samples be omitted. B. coli communis was usually present, but the average was only 11 per cu. cm.

BACTERIAL INVESTIGATIONS IN THE POLLUTED PORTION OF THE RIVER.

The bacterial analyses were begun in November, 1899, and extended to March, 1901, with the omission of the months of December, 1899, February and June, 1900, and January, 1901. The average figures for the whole period, at the points indicated, were as follows:

Locality.	Analysis of Samples. Distance from first point, miles.	Bacteria per cu. cm. Total.	Coli communis
Asylum	0.0	7,000	13
Water-works	2.0	13,000	46
Ferry I.	2.6	20,000	177
English Bridge	3.6	23,000	321
Ferry III.	4.5	19,000	600
Uffington	6.75	17,000	142
Atcham	11.0	13,000	48
Cressage	18.0	5,000	36

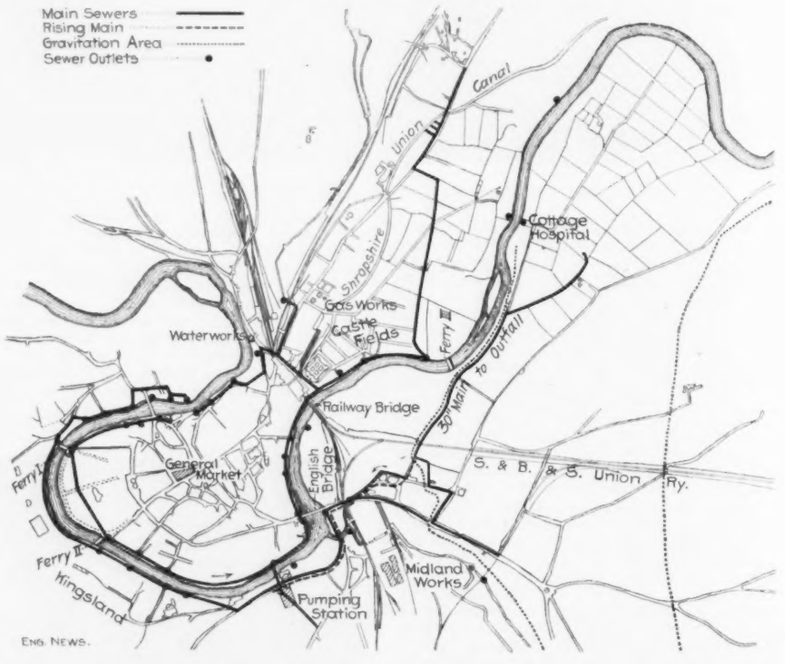


FIG. 1. MAP SHOWING THE MAIN DRAINAGE SYSTEM OF SHREWSBURY AND SOME OF THE POINTS IN THE RIVER SEVERN AT WHICH SAMPLES WERE TAKEN.

Fig. 1, which is a map of the "Shrewsbury Main Drainage," shows the location of sewer outlets and also of some of the sampling points named in the foregoing table. Fig. 2 shows graphically the average numbers of all bacteria, and of B. coli found at the various points. In further explanation of the results it may be said that pollution begins above the water-works intake and is its heaviest in the vicinity of the English Bridge. What may appear to be relatively small number of germs amidst so much pollution is ascribed to the dilution by 100 parts of river water.

Several variations affected the bacterial contents, the average being exceeded in dry, warm weather, when the river was low. Surface samples and those collected 2 ft. below did not show great bacterial differences, "more commonly the superficial contains more bacteria than the deep sample, but in many instances this is reversed." The authors recommend that samples, in such investigations, be taken "at numerous points from bank to bank, and then mixed" before analysis, a method followed in the latter part of these studies.

*See Eng. News, Oct. 9, 1902, for a lengthy abstract of other portions of this report.

†This water is furnished, without filtration, for general domestic purposes, other than for drinking. Water for drinking is brought from a distance, but is supplied from street stand-pipes only.

B. enteritides sporogenes was usually "absent when B. coli was absent, namely, in the comparatively pure parts of the river * * * it has occasionally been absent also in obviously polluted parts" of the river.

STUDIES OF RIVER MUD.

Samples of mud, 32 in all, were taken at the water line and examined for B. coli communis and B. enteritides sporogenes. B. coli varied from 25 and 43 per cu. cm. above the asylum (that is, above the first serious pollution) to 100,000 in many places in Shrewsbury, and 432,000 in certain stagnant bays within that town. It was also found for 18 miles below, but seems to have disappeared before the lowest point of serious pollution was reached.

Samples from the river bed were obtained by means of a cylinder, lowered to the mud, and connected with an exhaust pump. Above pollution, 70 B. coli per gramme of mud were found; opposite the first large sewer in Shrewsbury, 300,000; a little lower, 1,200,000; and a few miles below 5,200 and 900. As far down as 18 miles the germs were found.

THE SEWAGE FUNGUS.

This organism has long been recognized, the report states, as an indicator of sewage contamination. It was studied at several localities, including Atcham Brook, a tributary of the River Severn, and the River Alt, which flows by the

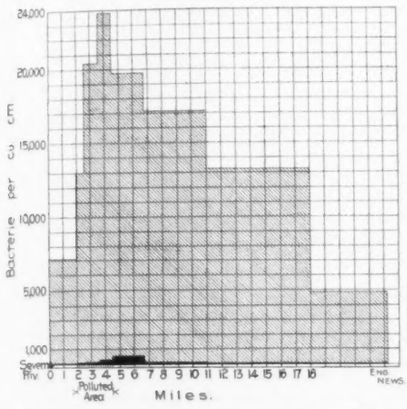


Fig. 2. Effect of Pollution Upon the Total Number of Bacteria and the B. Coli Communis in the River Severn.

(The black area indicates number of bacteria coli. The hatched area shows total number of bacteria.)

West Derby sewage farm. It was also observed at Dewsbury, Leeds and Birmingham. The report states that

> The fungus is a gelatinous, cottonwool-like, and wavy, white or reddish growth, which is found in shallow water, covering stones, lining drain pipes, or attached to water plants and debris; we have also found it in abundance in urinals. It is an unmistakeable indication of sewage contamination, and quantities of it are often to be seen in the streams of sewage farms, and in the small drains and brooks highly charged with sewage which are found in the vicinity of houses and villages in the country.

At Birmingham, England, screens have been provided to prevent the passage of the fungus into the river, "where it would have produced a nuisance by setting up 'secondary decompositions.'" At one of the sewage farms at Berlin, Germany, the fungus was seen "adhering to the debris in the small effluents." Atcham Brook, already mentioned, was almost choked with the fungus, the growth being "white, the tufts wavy and very gelatinous." Until this growth was discovered the brook was supposed to be unpolluted, but bacterial tests showed 19,000 coli communis per cu. cm., and an examination showed a concealed sewer outlet from a workhouse, and also a small feeder of quite pure water, "the combination of clear running oxygenated water with sewage" seeming "to be necessary for the development of the fungus."

ACTION OF THE PRODUCTS OF DECOMPOSITION DISSOLVED IN THE RIVER.

There can be but little doubt, the authors believe, that the products of bacterial decomposition in river water act injuriously upon fish life, since the bacterial life processes absorb oxygen and produce carbonic acid and other gases. In the Severn, "large anaerobic deposits of sludge in certain places in the bed of the river" emit sulphuretted hydrogen, "and will, therefore, affect the fish." Furthermore

> The fish are also indirectly affected through the plant life in the river. The aquatic plants not only themselves serve for food for certain fishes, but they also harbor the lower forms of animal and vegetable life which help to support fish. We have observed that the green aquatic plants do not grow near the anaerobic decomposing mud, they require oxygen, and it is most probable also that they are as sensitive to dissolved sulphur and other gaseous compounds as are land plants. But this is again a subject which requires much further investigation. We do not wish to overstate the danger to fish life of pollution. Undecomposed sewage, or a non-putrescible effluent is probably innocuous, and it can also readily be understood that a small quantity of sewage entering a river may be rapidly decomposed by bacteria, and contribute largely to the support of the lowest forms of plant and vegetable life, and these in their turn to the higher forms. This does take place and is comparable to the advantage on land of judicious manuring. We have, however, at Shrewsbury described excessive pollution, a condition which unfortunately exists in many rivers and which sooner or later produces changes which render higher animal and vegetable life impossible. In addition to bacterial poisons there are numerous instances of the poisoning of fish through mineral poisons discharged into sewage, finding their way into rivers.*
>
> If our knowledge of the harmful effect of the dissolved products of bacteria is very slight, that of other dissolved products, such as toxines, is still less, and we take this opportunity of drawing the attention of the Royal Commissioners to the lack of information concerning the action of these poisonous substances in water which appear to play an important part in the reduction of animal and vegetable life in our polluted rivers. The few experiments which we have made appear to show that the effluent from a Whittaker bed is less toxic than that from a Dibdin bed, and certainly less than septic tank fluid or crude sewage.

COMPARISON OF CHEMICAL AND BACTERIAL RESULTS.

Putting the chemical results obtained by Mr. Colin C. Frye alongside the bacterial results, it appears that the albuminoid ammonia, oxygen absorbed and chlorine were high when B. coli were low, but the variations in free ammonia and B. coli correspond closely. The total number of bacteria appears to have agreed fairly with the general conclusions from all the various chemical determinations.

SELF-PURIFICATION OF THE RIVER SEVERN.

The investigation of this phase of the subject was mostly "confined to tracing out as accurately as possible what became of the pathogenic bacteria which found their way into the river," but enough information upon the general subject of self-purification was obtained to make the authors entirely agree with the recent conclusions of the German government "that the enquiry is a vast one, and that a great deal of research is still required."

DESTRUCTION OF INTESTINAL AND PATHOGENIC BACTERIA IN THE RIVER.

The evidence already presented shows that the intestinal organism, B. coli, rapidly decreases in numbers at successive points below the introduction of polluting matter. This is due to subsidence and to side adhesion to the banks and vegetation of the stream. Temperature and other environmental conditions are not only unfavorable to the multiplication of these germs in the water and mud, but, in common with the other germs, they suffer from lack of food, due partly to dilution, and finally die.

DESTRUCTION OF ORGANIC MATTER IN THE RIVER.

The coarser fish, rats and birds, it is believed, "act as very efficient river scavengers." The marginal flora retain much organic matter, and sedimentation deposits more. Once organic matter is incorporated with the mud of the banks and bed of the stream, the former

> is decomposed by bacteria, just as in the case of manure or sewage on land or in contact beds. Aerobic fermentation takes place in the "wind and water line" * * * and reduces the organic matter to nitrates and to other foodstuffs, which can be readily taken up by the green plants along the banks. * * * We compared the action taking place in these sludge accumulations to that in the septic tank; anaerobic and H_2S forming bacteria develop, the mud is black, offensive gases are evolved, and there is no green submerged aquatic plants in their vicinity, because of the injurious products which are formed. * * * The shallow oxygenated river bed supports a luxuriant growth of the Water Ranunculus and Myriophyllum, the leaves of which are finely divided and adapted in a remarkable manner to strain the water flowing through them, as can be seen by the debris and mud which can be dislodged from them if they are disturbed. When the particles are arrested they are no doubt taken up by bacteria, and by the lower forms of animal life, and are reduced to substances which go to nourish the plants which retain them. The decomposition of the solid matter, whether proteid, fatty or carbohydrate, is thus accomplished by the aerobic and anaerobic bacteria, which are present in the sewage and sludge, and the grit and insoluble mineral constituents gradually collect on the bed of the river and lead in time to silting. The bacteria are not alone in this destructive process, representatives of the lower forms of green algae and the protozoa take a share.

Soluble organic matter also disappears, probably due to both chemical and biological action. Sewage fungus, particularly Sphaerotilus natons, plays a most important part in the process, apparently acting vigorously upon sulphuretted hydrogen.

THE FLORA OF THE RIVER SEVERN AND ITS SHARE IN PURIFICATION.

A survey of the flora was made in June, a time of the year when the water is low and the "water ranunculus covers extensive reaches of the river with its white flowers." The "wind and water" zone, which is kept moist by stream fluctuations due to slight changes in water level, to wind action, and to capillary attraction, "is for the most part free from vegetation, and consists of "an exposed mud bank, where the conditions favor the collection of organic material and conduce to bacterial activity, which may be compared to the action taking place "in a contact bed or in irrigated land." This mud zone, where polluted, "becomes covered with euglena, oscillatoricæ, closterium or other protophytes."

The deeper portions of the permanently submerged banks support a variety of vegetation, including Ranunculus aquatica, and the shallower parts give rise to sedges, alisma, water grasses and willows. Close in shore, in sluggish water, pond weeds grow. The water Ranunculus is more abundant above and below than in Shrewsbury. This plant grows best in swift currents, where the water is comparatively shallow, very little being found in June (when the river was low) at depths of over 4 ft. In places the weed forms a compete barrier from bank to bank. It grows in "wavy tufts 6 to 10 ft. in length, which are composed of finely branching stems and leaves," forming "huge bundles which float in the water and send to the surface the flowering stems." These plants retain large quantities of suspended polluting matter, as do various other aquatic plants. Besides rendering such notable service as this the aquatic plants "give off great quantities of oxygen in the presence of sunlight." Adhering to the plants are numerous protophytes, protozoa and bacteria, which doubtless "take a share in getting rid of the impurities held up by the meshes of the more highly organized plants."

It is considered both remarkable and fortunate that in the summer, when the sewage is less diluted than at other times, and "when putrefaction is much more active, the harmful effects of bacterial activity appear to be so soon neutralized." In winter the filtering action of the plants is of course much less, but even then the fine, drooping branches of the willow strain out some of the coarser matter, and of course the dilution is then much greater than in summer.

Professor Boyce sums up the whole study (January, 1902) as follows:

> (1) That the B. coli is a most reliable test of pollution.
> (2) That the B. coli is normally absent in 1 cu. cm. quantities of water taken from the Vyrnwy watershed of the River Severn.
> (3) That when the B. coli is present in a small stream, contamination from houses can be traced.
> (4) That small land drains are comparatively free from B. coli.
> (5) That the small streams running into the Severn often contain considerable quantities of the B. coli due to contamination from proximity to houses.
> (6) That the sewage of Shrewsbury causes a very great increase in the number of B. coli in the river, and that sixteen miles lower down the effect of pollution can still be detected by the number of B. coli present.
> (7) That there is no evidence of the multiplication of the B. coli in the river water.
> (8) That the B. coli is present in considerable numbers in the mud of the Severn in the polluted area, and that this mud may be the means of keeping up and extending pollution, but that there is no evidence of the multiplication of the B. coli in the mud.
> (9) That there is comparison between total numbers of bacteria and the B. coli, but the relative proportion of the numbers of the latter to the former is small.
> (10) That differences occur between the number of B. coli in superficial and deep samples, and samples taken near the banks and in stagnant bays, and that therefore cross section samples should always be taken.
> (11) That sedimentation and side adhesion to the banks of the solids in suspension take place, and that at places in the bed of the river anaerobic fermentation occurs, whilst along the banks, especially in the wind and water

*The increasing use of carbolic acid as the common domestic water-closet disinfectant, and the large use of disinfectants by municipal authorities, will probably in time produce effects in rivers.

line, aerobic bacteria actively help to destroy the organic matter.

(12) That certain places in the river are very deep, and that these act as catch pits, that the stream in these places is sluggish, and the sedimentation is favored.

(13) That in the destruction of organic matter, whether solid or in solution, whilst the bacteria take the greatest share, help is also rendered by the protozoa and higher forms of animal life, by the sewage fungi, the chloropyll containing protophytes, and the river plants.

(14) That the Sphaerotilus natans is a test of sewage pollution, and that it is a purifier of sewage.

(15) That there is no evidence to show that pathogenic bacteria multiply in either the water or mud of the river.

(16) That seasonal variations in the number of bacteria occur, but taking the B. coli as the test for pollution that the number of this organism is dependent upon the numbers present in the sewage entering the river, and that when the river is swollen and muddy the number is small owing to increased dilution, and that when the river is low the number is large owing to the lesser degree of dilution which the sewage undergoes when it enters the river.

(17) That the effect of dilution of the river upon the sewage of Shrewsbury is most marked. That the average maximum number of B. coli in the river is only 600 per cu. cm., which is much less than in an average Dibdin effluent, whilst a short distance below pollution the number decreases very considerably.

(18) That there is a relationship between chemical and biological analyses.

(19) That the River Severn is a good example of a river which it would be difficult to class either as a potable or non-potable stream. It is true that the inhabitants of Shrewsbury consider it as non-potable, for they do not drink the water; but they use it for washing purposes, and consequently there is always a liability for, say, milk to become contaminated by being kept in a can which was washed with the river water. This liability is increased by the fact that the river is practically used as a tidal river, receiving as it does the whole of the untreated sewage of the town. Again, the river in close proximity to the town is used largely for watering cattle. Cattle may therefore contract disease from the water, and such disease may be communicated to human beings.

The river is also used for fishing, and has a recreative and ornamental value.

For these reasons we consider that it is as worthy of protection from pollution as any so-called potable river.

That whilst it would be onerous to expect absolute sterility in any effluent running into such a stream unless some simple method of sterilization was discovered, yet a certain degree of bacterial purity, as shown by the B. coli test, might be insisted upon in addition to the chemical tests, for it would indicate the extent to which the intestinal bacteria were reduced by the method of sewage treatment employed.

(20) That what has been described in this report upon the effects of allowing crude sewage to enter the River Severn is also applicable to biological effluents. Crude sewage is an example of the worst form of pollution, the effluents from biological methods of treatment examples of a lesser degree of contamination, because the solids in suspension in the latter are far less in amount and are in a fine state of division, and the number of the B. coli is smaller.

Shrewsbury, with 29,000 inhabitants, and turning crude sewage into the Severn, causes an average pollution of 600 B. coli communis per cu. cm. (at the point of maximum pollution), and this is felt 16 miles lower down. But if a large town like Leeds were similarly situated, and the sewage were purified by contact beds so as to contain 10,000 B. coli communis per cu. cm., the pollution would still be about 1,000 B. coli communis per cu. cm., and if 600 B. coli communis are felt for 16 miles, 1,000 would be felt still further down. Consequently, in spite of the artificial purification, such a river would be in a worse condition than the Severn at Shrewsbury, which is admittedly bad. It follows that the purification thus attained would be insufficient, and that some further treatment would still be necessary.

Therefore a bacteriological examination of sewage effluents is necessary so as to ascertain whether the river can deal effectually with the sewage of its town.

CHEMICAL STUDIES OF THE SELF-PURIFICATION OF THE RIVER SEVERN.

These studies were made by Mr. Colin C. Frye, and were confined to some 30 analyses of samples taken in mid-stream at seven points, ranging from two miles above to 16 miles below the Shrewsbury water-works intake. In general, they accorded with the many similar analyses made elsewhere, which, as is well known, show a marked diminution of organic matter after a few miles of stream flow.

ELECTRIC PUMPING PLANT AT THE BRIDGEPORT STATION, CHICAGO, FOR THE ILLINOIS & MICHIGAN CANAL.

The Bridgeport pumping station on the Chicago River at Ashland Ave. was established about 1850 as a part of the plant of the Illinois & Michigan Canal, its purpose being to supply water to the canal in time of drought. The canal extends from Bridgeport to La Salle, on the Illinois River, 100 miles, and was completed in 1847. The navigation upon it is now quite limited, but as it furnishes water for power purposes it is necessary to maintain a full water supply. In 1860, owing to the sewage pollution of the Chicago River, Mr. E. S. Chesbrough, then City Engineer, recommended that the city should pay the State Canal Commissioners to pump enough water from the river to maintain it in comparatively inoffensive condition. This was done for some years, but in 1871 the summit level of the canal was deepened and the pumping station was abandoned. About 1877, however, the city rebuilt the station in order to create a current westward in the south branch of the river and to discharge the sewage laden water into the canal. The effects were not what had been expected, however, but the plant was kept at work by the city, being used for the combined purpose of removing the sewage and feeding the canal. On the completion of the Drainage Canal in 1901, the city turned the Bridgeport pumping plant over to the Sanitary District, which concluded to remove the machinery and abandon the station as being no longer necessary for the disposal of sewage. It was necessary, however, for the canal commissioners to maintain a supply from this plant, not only for navigation, but also for the water power plants at Lockport, and the burden of maintaining the supply was thrown upon the State. The matter was submitted to Mr. Thomas T. Johnston, Consulting Engineer, Security Building, Chicago, who designed the electric pumping plant recently put in operation.

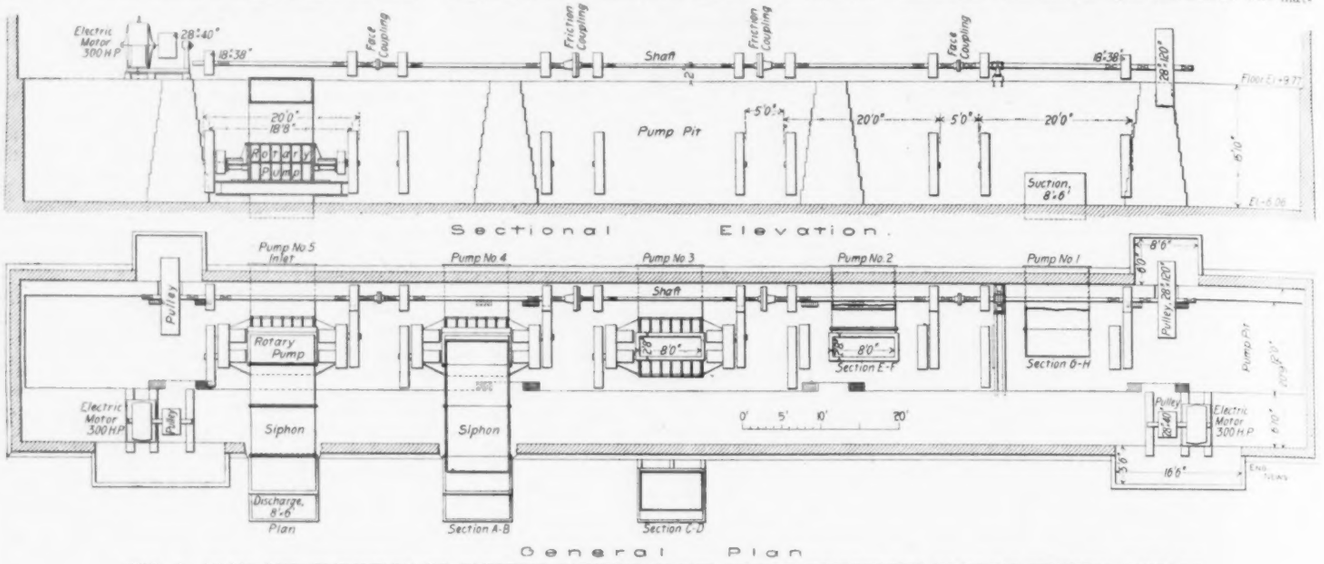


FIG. 1 PLAN AND ELEVATION OF ELECTRIC PUMPING PLANT AT THE BRIDGEPORT PUMPING STATION, CHICAGO.
T. T. Johnston, Consulting Engineer.

The pumping machinery used at this station has been of a varied character. The first pumps used were of the "Dutch" or breast-wheel type, the wheels being driven by steam power and having buckets around the rim to elevate the water. In 1884 these were replaced by eight centrifugal pumps with a combined capacity of 60,000 cu. ft. per minute, or a little more than the maximum flow of the canal. In 1893, these in turn were replaced with a pair of Courtright undulating pumps, described in our issue of July 27, 1893. In the same year, however, one of these pumps was wrecked by solid matter entering it, and both were then removed and the old centrifugal pumps put back. These latter remained in service until the pumping station was abandoned by the city. A test of the efficiency of the plant was described in our issue of Dec. 2, 1897.

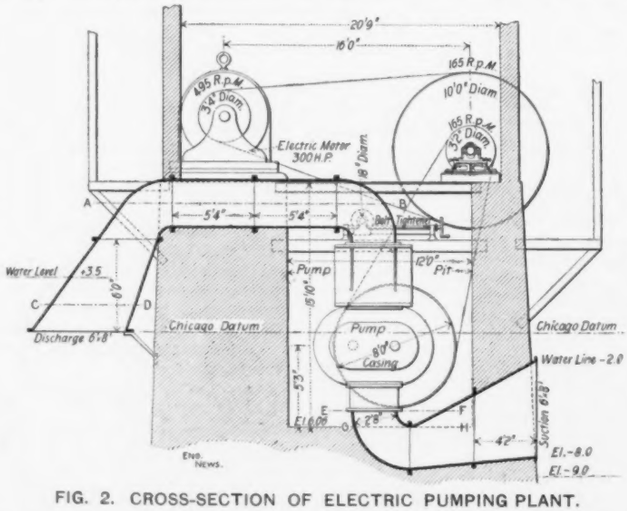


FIG. 2. CROSS-SECTION OF ELECTRIC PUMPING PLANT.

The present plant consists of five retary impeller pumps, built by the Connersville Blower Co., of Connersville, Ind., and placed in a row in the old pump pit, as shown in Fig. 1. Each pump is belted to a pulley on a shaft running along the wall of the building, and at each end of this shaft is a main pulley belted to a 300-HP. motor built by the General Electric Co. The shaft is fitted with friction clutches on either side of the middle pump, so that two, three, four or five pumps can be driven as required. The suction lift is about 2 ft. to 4 ft., and the total lift from

river to canal about 6 to 8 ft. In consequence of the slight natural head of water above the pump the discharge is through a siphon which maintains a net head equal to the difference between the head and tail water levels. This arrangement is shown by the section, Fig. 2.

The inlet and discharge openings are 6 × 8 ft., and the vertical dimension of the siphon is 36 ins. The openings in the pump casing are 2 ft. 8 ins. × 8 ft. The impellers are 8 ft. long, with a maximum diameter of 4 ft., and a pitch diameter of 32 ins. (c. to c. of shafts). The pumps run at about 66½ revolutions per minute, and have a capacity of 100 cu. ft. per revolution, or a maximum capacity of 33,250 cu. ft. per minute for the entire plant. This is equivalent to a maximum load of 500 HP. The velocity is 2.3 to 2.4 cu. ft. per second at the inlet, and higher than this in the siphon. An elevation and section of one of the pumps are given in Fig. 3, and a special

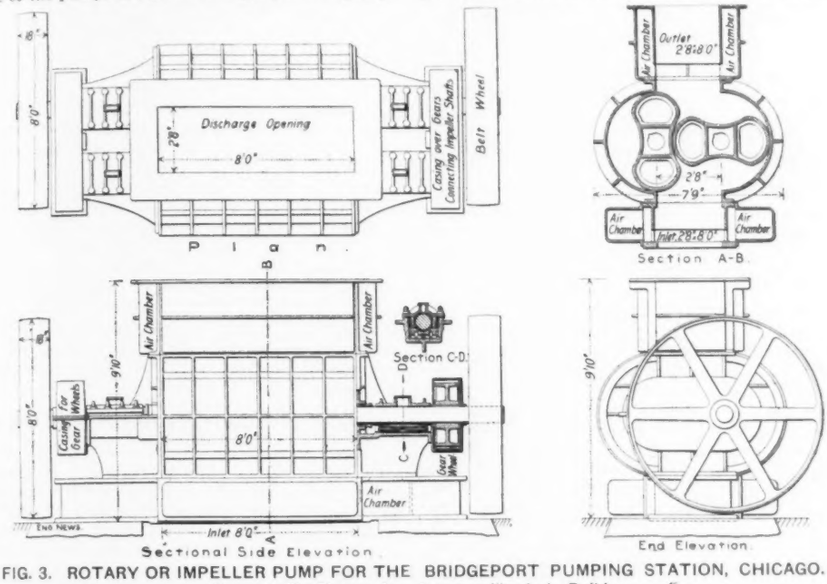


FIG. 3. ROTARY OR IMPELLER PUMP FOR THE BRIDGEPORT PUMPING STATION, CHICAGO.
Connersville Blower Co., Connersville, Ind., Builders.

feature of the design is the arrangement of annular air chambers above and below the pump chamber. The contracts for the plant were awarded in Dec., 1901, and the plant was installed by April, 1902. As the construction of the transmission line from Joliet was delayed by litigation, however, a temporary steam plant was installed in one of the old boiler houses, and belted to the shaft. The pumps were thus driven during the summer, but on Dec. 31, 1902, the electric plant was put in operation.

The plant is operated by electricity generated at the water power plant of the Economy Light & Power Co., at Joliet, Ill., 34 miles distant. A high-tension alternating current of 30,000 volts is brought to the station by a long distance transmission line, and then stepped down by transformers to a 2,300-volt alternating current, which is delivered to the induction motors. This is said to be the first time such a combination of motors and transmission system has been employed for driving impeller pumps, and it is suggested that the arrangement is well adapted for irrigation pumping plants. It is also uggested that this plant is an example of what the city of Chicago might effect by utilizing the water power of the Drainage Canal to generate electric current to be transmitted to the city and used in the city pumping stations and for other purposes.

The cost of operating the plant is estimated at $18,000 per annum, but the Canal Commissioners receive $10,000 per annum for water power thus supplied, so that the net cost will be only about $8,000 per annum. Formerly, when using steam pumps, the cost was from $45,000 to $125,000 per year.

AN INTERNATIONAL CONGRESS of arts and sciences is to be held in connection with the Louisiana Purchase Exposition, at St. Louis. The Administrative Board has appropriated $200,000 for the Department of Congresses, and Prof. Simon Newcomb, of Washington, D. C., has been appointed President of the Congress of Arts and Sciences, with Prof. Hugo Muensterberg, of Harvard University, and Prof. Albion W. Small, of Chicago University, as Vice-Presidents. This Congress is to convene Sept. 19, 1904, and leading scholars from the whole world will be invited to discuss every theoretical and practical science, to trace the development of science in the last century and to state present open problems. All the proceedings are to be published at the expense of the Exposition. This is the first attempt of any international exposition to hold a series of related congresses all tending towards the development of one central idea; and it is the first time that a definite sum has been set aside to pay the traveling expenses of every one submitting a paper in response to an invitation to contribute a definite piece of work to the uniform plan.

NOTES FROM THE ENGINEERING SCHOOLS.

UNIVERSITY OF MICHIGAN.—At present the engineering department is making more rapid gains, as regards students, than any other department of the University. The number of persons studying engineering this year is about 600, which is over 100 more than the number enrolled last year, and is nearly 250 more than two years ago.

Since 1898 the number of persons studying engineering has been increasing, as will be seen by the following figures:

College year.	Number of Eng. Students.
1898-1899	245
1899-1900	280
1900-1901	359
1901-1902	489
1902-1903	(about) 600

RENSSELAER POLYTECHNIC INSTITUTE.—Dr. William L. Robb has been appointed Professor of Electrical Engineering, and has taken charge of the Electrical Department with two capable assistants.

The Chemical Laboratory and the Proudfit Memorial Building, which were recently partially destroyed by fire, are being rebuilt. Both will be greatly improved. The chemical laboratories will be contained in two adjacent and connected buildings. These buildings contain ten rooms and include a large lecture room equipped with facilities for lectures on general chemistry, two large main laboratories for quantitative and qualitative analysis, one small laboratory for special work, a laboratory containing the necessary furnaces and muffles for assaying, and a special laboratory for the analysis of water. There is also a library containing special works on chemistry, and a recitation room.

The Proudfit Memorial Laboratory will be greatly enlarged. As completed the main building will have three stories and a basement. There will be 16 rooms. Thirteen of these rooms will be used for the laboratories and lecture rooms of the Department of Physics and Electricity. Unusually complete sets of generators and motors with the necessary meters, indicators and brakes, as well as a large storage battery, will be installed in the electrical laboratory. One room will be used for a shop for the construction and repair of apparatus. The other three rooms in the building will be used as laboratories for the Department of Mechanics. One will contain the 100,000-lb. and 300,000-lb. testing machines driven by an electric motor as well as a wire-testing machine and one of 50,000 lbs. capacity for testing long columns. Another room will be completely equipped as a modern cement testing laboratory. The third will contain a rattler for testing paving bricks.

Adjacent to this building will be the boiler house containing two 75-HP. Babcock & Wilcox boilers, one with a superheater for experimental tests. This building will also contain a steam turbine.

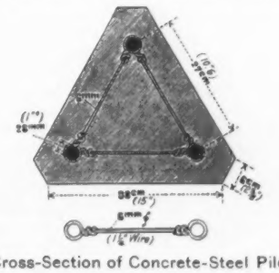
A CONCRETE-STEEL PILE FOUNDATION.

Piles made of reinforced concrete have been used before this, both built in place and driven; they are a new style of construction, however, and very few engineers know much, or even anything, about them. A brief note of a recent case where they were employed may be of interest.

A courthouse was to be constructed near the city of Berlin, Germany, and it was found necessary to resort to piling to get a suitable foundation. However, the ground-water level in that vicinity had shown great fluctuations in recent years, and it was thought possible that it might in the future fall below the top of the foundation; wooden piles were out of the question, therefore. It was finally concluded to use piles made of concrete reinforced with steel.

The form of pile adopted is shown in the accompanying cut, taken from the "Centralblatt der Bauverwaltung"; the piles are triangular in section, following a triangular arrangement of the reinforcement steel. This latter comprises mainly three rods longitudinal to the pile; those rods are round, 1 in. in diameter, and are tied together by ¼-in. wire ties set at intervals of about 8 ins. At the bottom end of the pile the three rods converge to a point and are welded together. The concrete used is made of high-grade Portland cement and clean river gravel, in the proportion 1 to 3.

The method of constructing the piles was as follows: The molds or forms were set up vertically and the concrete placed into them in 8-in. layers. The concrete was mixed very carefully, in machine mixers, a minimum amount of water being used. Of the three sides of the mold, two sides were set up in full height, with the three 1-in. reinforcing rods in place, and the third side was built up as the ramming-up of the pile progressed. Each 8-in. layer of concrete was rammed down as hard as could be done with hand ramming; then the surface was roughened with a trowel, a set of spacing ties put on the reinforcing rods and a further layer of concrete put in. Piles were built in this way in lengths varying from 16 to 26 ft., as required. When molded complete, the pile was left to set for about a day, without



Cross-Section of Concrete-Steel Pile.

water, and was then kept in the form for a week longer with continual sprinkling. By that time the concrete had hardened sufficiently to allow the piles to be lifted vertically out of the forms and set away in vertical position for another period of a week or more, during which time they were kept constantly wet. After this they could be removed for transportation or storage.

The piles were driven by steam-hammers weighing as much as 5,000 lbs., with a fall of about 5 ft. The head of the pile was protected from damage in driving by a cushion cap made of alternate layers of iron plate, wood and lead, which was clamped to the pilehead. This cap also served to guide the pile in the leads.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

There have been repeated reports that the Great Northern Ry. was to adopt electric traction for the movement of trains through its Cascade tunnel; and we trust that the recent accident in the tunnel, in which a passenger train became stalled and a large proportion of those on board were rendered unconscious by gas, will have the effect of inducing the management to take prompt action in the matter.

Engineering News, as its readers know, has maintained a very conservative position respecting the application of electricity to steam railways; and has also advised the use of fans for tunnel ventilation where circumstances favor such a system. But for such long railway tunnels as the Cascade tunnel or the St. Clair tunnel, where the conditions prevent the use of ventilating shafts, and particularly where steep grades make necessary the use of large amounts of power in hauling trains, there can be no question that a change to electric locomotives is the only prudent course to adopt. From the accounts which reach us of the conditions on the stalled train, the railway company narrowly escaped having to pay damages for loss of life which might easily have amounted to more than the entire cost of equipping the tunnel for electric operation.

New York city wants a railway commission all its own to look after its street railway companies and keep them "up to the scratch," and a bill has been sent to the legislature for that purpose.

We fail to see any wisdom or benefit in such legislation. There is reason in giving a city authority to deal with its own franchise-holding companies, so that it may hold such companies to proper observance of franchise requirements. But when a city has given away franchises for nothing, without restrictions, as New York and hundreds of other American cities have done, only the power of the State can intervene to compel the observance of public obligations by these public service corporations. If this power is delegated by the legislature to a commission, it may as well be the existing State Railroad Commission as a new body of men. In fact this is the proper work of the State Railroad Commission and there is no more reason for establishing an independent local commission to do the work in New York than there would be in Buffalo or Albany.

It may be said in addition that a State organization handling matters of this sort obtains as a rule a broader view than any local body is apt to have and is freer from local prejudices and partisan influences than any local body is apt to be.

The paper on the premium plan of paying for labor by Mr. Richards in this issue is worth the careful study of every reader who has to do with the management of men. It is well known that the premium system and the bonus system have met strong opposition on the part of the workmen in many cases; but so far as we recall, no criticism of these systems has hitherto appeared in engineering literature. Mr. Richards takes up the subject from the workman's standpoint and shows some of the reasons why the workman opposes these systems.

There is no doubt that in the present state of industry one of the largest factors in the success or failure of any enterprise is the management of the working force. How can the men be induced on the one hand to render such faithful and diligent service as will enable the business to be carried on at a profit, and on the other hand, how can they at the same time be made so well satisfied with their wages and conditions of labor that strikes and labor difficulties of all sorts may be avoided? This is the problem over which managers and superintendents are everywhere puzzling. It must be evident that the first necessity for a solution of the problem is to get at the workman's point of view. Any system adopted without regard to this may prove a disappointing failure. It is because Mr. Richards presents the workman's side of this question that his paper is calculated to be useful to those in executive positions.

As stated in one of our recent issues, the Municipal Explosives Commission of New York city has refused to personally investigate the merits of any of the safety explosives. The commission has taken the ground that it is not within its province to discriminate against any particular kind of explosive, although, as we have pointed out, it has actually discriminated between different explosives by excluding from use liquid nitroglycerin and high-percentage dynamites. We commend the commission for this latter action, but we believe that it has not gone half far enough.

The New York Herald of Feb. 5 had the following relative to this matter:

> The safety explosives manufacturers say that while they are able to dispose of their explosive outside of this city, here they are unable to introduce their wares on account of the arrangements that are in force between contractors, especially on the rapid transit subway work, and the "Dynamite Trust." J. Amory Haskell, president of the Laflin & Rand Powder Co., and member of the Municipal Explosives Commission, yesterday denied both of the allegations.
>
> The members of the Municipal Explosives Commission are Fire Commissioner Thomas Sturgis, William J. Charlton, George O. Eaton, J. Amory Haskell, Charles F. McKenna, Ph. D., and John F. Cunningham, secretary.
>
> J. Amory Haskell, when seen at his office, No. 99 Cedar St., yesterday, said:
>
> This matter is going before the Mayor, and I do not see the necessity of saying anything. What the Explosives Manufacturing Co., of Elmira, wants is a special dispensation. But then, they have not demonstrated that their wares will not explode, and especially if one of their cartridges with a cap attached should be placed in a magazine where there were others of their cartridges. Their goods are not used in this city.
>
> There are some contracts in the subway work that may restrict the contractors to the use of certain explosives, but there is no general government of contractors that I know of. No; there is no discrimination on the part of the commission, and no dispensation can be given until the so-called safety explosive manufacturers demonstrate that their goods are as represented.

Mr. Haskell's statement that "no dispensation can be given until the so-called safety explosive manufacturers demonstrate that their goods are as represented" seems worth a little comment.

We fail to see how the manufacturers of safety powders are ever going to make the "demonstration" required so long as the commission refuses to subject any of the safety powders to tests. At the public hearing of the commission, at least two of these manufacturers of safety explosives urged the commission to test their powders, but the commission, in the person of its chairman, shook its head, and replied: "Time alone will prove the merits of your claims."

Now, the picric powders have been in use in the United States for some eight years and for a much longer time in Germany and France. It is a pertinent question, therefore, how long a time the Commission considers will be necessary to establish the claims made for the picric powders.

A year or more ago, just after the dynamite explosion in the New York subway, the public was clamorous for the adoption of all sorts of measures to prevent accidents from explosives in the city. One prominent New York journal urged that explosives ought to be discarded altogether in the tunnel construction and advised that the work be prosecuted by breaking the rock with alternate applications of liquid air and hot water, if we rightly remember. The Municipal Explosives Commission was in fact created in answer to the outburst of public criticism following that explosion; but we fear it will take another great explosion and loss of life to cause that body to take the radical action which the situation demands.

It is absurd to say that dynamite is safe when reports of fatal accidents in its use are published almost every day. If its use were a necessity, the danger would have to be endured; but when safe substitutes are offered, the municipal explosives commission of New York city shirks its plain duty when it fails to subject them to tests.

AUTOMATIC STOP ADJUNCTS TO THE BLOCK SIGNAL SYSTEM.

The recent epidemic of serious railway collisions, and particularly the Westfield disaster, occurring on a road equipped with a first-class block signal system, has turned public attention to devices for preventing collisions. The newspapers are full just now of the work of inventors in this field, coupled with lamentations of the editors that the railway managers should be so hard of heart and so regardless of the safety of the traveling public as to turn a cold shoulder to these inventors.

So much matter of this sort is finding publicity in the daily press that it may be proper for us to state the real attitude of railway officials toward inventions of this class. We venture to say that the operating officers of railway companies appreciate to the full their responsibilities for the safe carriage of passengers. It is because they do feel this responsibility that the inventors of these alleged safety devices find it hard to get their devices adopted. The typical inventor of this class is densely ignorant of practical railway operation. Signal engineering, particularly, which has come to be, as most of our readers know, a highly developed specialty, is a sealed book to them. To expect a man of this type to develop a revolutionary improvement in signaling devices is absurd; and railway officers cannot be reasonably expected to take valuable time even to study out the weak points of the complicated contraptions brought to them by such inventors.

It is easy enough to invent a device which to the man unfamiliar with practical signaling appears to be a valuable improvement; but the point on which the railway superintendent and signal engineer must satisfy themselves is whether the inventor in combating one danger has not introduced nine worse ones.

For illustration, the newspapers have had something to say recently of a wonderful new invention, by which the engineer in his cab is placed in constant telephone communication with the engineers of other trains in front of and behind him, and can keep himself at all times informed as to their location. This may seem at first sight to the layman like an ideal scheme for securing safety from collision; but a little thought shows at once the great dangers it would introduce. The difficulties and delays and uncertainties that oc-

casionally occur in telephone conversations are familiar to all. Imagine the result of such difficulties and delays in train service. A train is rushing toward another at a speed of a mile a minute, and the engineer of a train which has stopped—just as the train stopped on the Jersey Central the other day—tries to telephone to the engineer of the train coming up behind. A slight imperfection in the connections prevents the telephone from operating, and the collision results. We might refer to the difficulty of using a telephone with the noise of the locomotive in one's ears, or to the accidents that would occur from an engineer talking to one train and supposing he was talking with another, or from the misunderstanding of messages, or to a dozen other probable chances of error. It is not necessary, however, to go into detail. There is not the smallest chance that such a system could come into practical use; and we only bring it forward as an excellent illustration of the thousand and one "safety" devices for railway operation which contain more danger by far than our present system.

Two weeks ago, in discussing the Jersey Central accident and collisions under the block system, we showed that English railways using the block system have succeeded in almost absolutely preventing collisions. As we stated then, English engine-runners obey their signals with unvarying fidelity; whereas American engine-runners have shown a frequent disregard of signals that is very difficult to explain.

We believe, as we stated two weeks ago, that with the more extensive use of the block system and the more thorough discipline of those running under it this disregard of signals will disappear.

It is true, nevertheless, that a certain tendency exists to look with favor on automatic adjuncts to the block signal. A large proportion of the block signal systems in use in this country are of the automatic type; and with such signals the managing officers have no means of knowing when an engineer runs past block signals at danger unless his disobedience results in an accident.

This is one reason, perhaps, why American railway officers are likely to regard some automatic adjunct to the signal with more favor than it has met abroad.

A good illustration of the trend of opinion toward the automatic stop idea is furnished by the report of the engineer of the Illinois Railroad Commission, an extract from which is printed on another page of this issue. We find in this same report some interesting figures on derailments at interlocked grade crossings of railways in the State of Illinois during the past year which are worth reprinting as showing the astonishing number of cases where engine runners have disobeyed signals set against them. The table is as follows:

	Number of cases where trains were derailed.
Trains running against signals	138
Towerman taking signals away from approaching trains, or throwing switch under moving trains.	11
Hand signals, when route was improperly set up.	6
Setting up wrong route	6
Defective interlocking functions (including defects caused by snow, ice, etc.)	7
Cars rolling out on main track (due to action of wind, etc.) and parting of trains due to collisions or other causes	2
Defective track or rolling stock	27
Total derailments at interlocking plants....	197

We can hardly wonder, in the light of the above record, that the Commission's engineer favors the use of an automatic stop with block signals; and this brings us to the question, which we are sure not a few railway superintendents and signal engineers are seriously considering, whether an automatic stop can be devised which will be a practicable and efficient safeguard against accidents due to engineers running past danger signals.

The general form which such an automatic device should take is pretty well settled. It should operate by applying the brakes and preferably also by closing the throttle. Numerous devices to accomplish this have been invented and some of them have been applied to a limited extent in practice. There is no reason apparent why such a device might not be made thoroughly effective and reliable. The first difficult question is, where should such a device be placed? The inventor usually plans to place it at the home signal; forgetting that the train must be stopped before it passes the home signal and that in order to do this the brakes must be applied a long distance back, if the train is running at high speed. It is particularly for the protection of the fastest trains that such a system must be planned.

To ensure that fast express trains shall be stopped before reaching the home signal, it will be necessary to place the automatic brake applying apparatus nearly or quite as far back as the distant signal, or from 1,500 to 2,000 ft. or even farther away. When we do this, however, we at once run into mechanical difficulties in the operation of the apparatus from the home signal. Signal engineers well know how the difficulties of operating distant signals by long lines of wire or pipe increase as they are placed farther from the home signal. The objection is even raised to the use of the distant signal that there is a chance that through failure of the connections it may fail to indicate "caution" when the home signal stands at danger. Should this occur, the engineer in thick weather would proceed at full speed expecting to find the home signal at safety and a serious accident might result, if the track were obstructed just beyond the home signal.

The same reasoning, it is clear, applies with even more force to an automatic stop apparatus. It must absolutely and certainly operate in unison with the home signal or it may prove a source of danger instead of safety. Some method of operation from the signal tower other than the ordinary pipe or wire connection would probably be necessary, such as a hydraulic or pneumatic connection.

We have said above that the apparatus should operate to apply the brakes, and this means unquestionably, for reasons that we will not take space to give in detail, the emergency application. Here, however, the inventor encounters another snag. Since the apparatus is supposed to be located back nearly or quite as far as the distant signal, it will be impossible for the train to stop before reaching it; thus trains will be running over the apparatus and having the emergency brake thrown on with consequent shocks, every time a train reaches a distant signal set at caution. It need hardly be said that this is wholly inadmissible. The automatic stop should only act when the engineer fails of his duty and when there is danger which justifies the use of the emergency brake with the consequent shocks.

It might be possible of course to so arrange the apparatus on the engine that it would only be operated by the track instrument of the automatic stop provided the service brake were not already in operation or provided the speed had not already been reduced to a certain limit. To the practical mind, however, such devices suggest too much of complication and leave too many loopholes open for failure. The conclusion must be, we think, that if the automatic stop is set say 1,500 ft. back of the home signal, then a distant signal must be placed nearly or quite as much beyond the automatic stop, thus making in effect three successive signals at the entrance of each block. The complication and expense which this would involve will be at once objected to; but the discussion has at least shown us a way out of the difficulty. This is to place the safety stop at the home signal and extend the protection of the home signal to a space of say 1,500 ft. or so in front of it, sufficient length for a train to be stopped in after passing the home signal. The block signaling rules of some railways now require a towerman not to report a train as passing out of the block until its rear is from 300 to 900 ft. past the home signal. If this space were increased to say 1,500 ft., the automatic stop could be placed at the home signal and made to operate on every train running past the home signal when at danger.

Of course there are some objections even to this. In many conditions of the weather, for example, a towerman cannot see when a train passes a mark 1,500 ft. away—or even 900 ft. for that matter. We imagine that the rule is one which would be very hard to compel observance. With track circuits, however, this difficulty would vanish, and so far as we can see it offers the best possible solution of the problem of locating automatic stops.

Finally, a common fault of the inventors of automatic stop devices is the attempt to make their apparatus the whole thing and dispense entirely with fixed signals or make them play a subordinate part. We hold this to be a serious mistake. Generations of experience have developed a system of fixed signals by the roadside as the safest known system for governing the movement of trains. It will not make for safety to transfer the duties of the engineer to automatic mechanism for that mechanism, necessarily complicated, may fail to operate at a critical moment. The cardinal rule of signaling that any failure of the apparatus shall give the danger signal cannot be applied to automatic stop systems. The proper function of an automatic stop is as a safeguard against the mistakes or inattention or sudden illness of the engine-runner, and a record of his failures that will spur him to more perfect vigilance.

A valued contemporary in opposing the use of automatic stops said recently:

> All machines thus far devised are liable to omit to give notice of the failure of some of their parts; and as their failure to act is equivalent to a go-ahead signal, a false indication may be given. With automatic stops it is harder to enforce human vigilance, for the runners will naturally depend on the machine.

This criticism would apply to an automatic stop system which was made the main reliance for governing train movements. It would not apply to such a system as we have outlined above, intended only to operate in an emergency when the indications of the block signal are disregarded.

Since the above was written the coroner's verdict on the Westfield collision has reached us and it will be seen from the abstract published on another page that one of its recommendations is the use of automatic stops in conjunction with block signals. This furnishes another evidence of the tendency of public opinion in this direction. We trust the above discussion may be of some service as showing on the one hand the difficulties in the way of the adoption of current inventions of this type by the railway companies, and on the other hand some of the lines on which any such invention must operate if it is to be a real safeguard in the movement of trains.

LETTERS TO THE EDITOR.

The Effect of Manure on Concrete.

Sir: Concerning the effect of manure on concrete I submit the following: In the winter of 1901-2 I was working as inspector on the construction of concrete bridge abutments in the Wasatch Mountains, Utah. On one job the contractor secured a lot of rather strawy stable manure, and each evening the concrete deposited during the day was sparsely covered with boards, which were, in turn, covered with 18 to 24 ins. of manure. When the abutments were partly built, work was suspended for several weeks, during which time there was a heavy fall of snow and alternate freezing and thawing. When work was resumed I examined the concrete carefully with a view to finding the effects of frost. The surface of the work was discolored, but the material was in first-class condition.

Respectfully, John Algie.

Lawrence, Kansas, Feb. 5, 1903.

[It will be noted that in this case there was no rain, and moisture seems an essential condition to the leaching of the acids in the manure which attack the concrete where cases of disintegration occur. It will also be noted that this manure was largely straw, and that boards intervened between it and the concrete. All conditions were therefore favorable to protection of the concrete without injurious action of the manure.—Ed.]

The Failure and Repair of the Bottom of a Wood-Stave Tank.

Sir: The numerous failures of wood stave water tanks, which appear so often in your columns, lead the writer to think that a similar failure he has experienced, and the method of repairing the same, might be of interest to your readers.

The tank in question was of cedar, 26 ft. in diameter, 14 ft. deep, and was used to store boiler feed water, which was about 150° F. temperature most of the time.

Without warning two of the planks forming the bottom gave away and allowed the tank to empty itself in a few seconds, almost scalding a number of workmen in the immediate vicinity. The staves forming the sides re-

mained standing intact. From an inspection after the accident it was decided that a small leak in the bottom of the tank had washed away the supporting sand at this point, and that the boards, spanning the washed-out space, broke under the weight of the column of water above, and were carried out from beneath the tank by the rush of water which followed.

To make the bottom tight again, and to avoid a repetition of the accident, the broken boards were replaced and a splice block nailed over the breaks. Six inches of concrete, with 3-in. mesh expanded metal 1 in. from the bottom, was put into the tank and allowed to set for several days. A coke fire was now burned inside the tank for three or four days to dry out the concrete and also the wooden staves. The joint between the sides of the tank and the concrete bottom, and the bottom of the tank itself, were thoroughly coated with "Cerion" paint. The hoops were driven down tight and the tank was allowed to stand until the paint was dry, when it was filled with water and found to be perfectly tight, and has remained so ever since.

A bottom of this description is easily put in and makes a superior one to that of the original, as it will not only beam across any low or soft spots in its bed, but will also distribute the load more readily.

Yours truly, John Lathrop Gray.

East 22d St., Bayonne, N. J., Feb. 9, 1903.

(In original construction most engineers would prefer to place the concrete, with its thickness multiplied a number of times, beneath the wood bottom of the tank. It may be added that most of the recent wood tanks that have failed have been elevated structures.—Ed.)

The Discipline of Locomotive Runners in the Observance Signals.

Sir: Your editorial in your issue of Feb. 5, on "Some Lessons of Recent Collisions" has been perused with interest and its conclusions are fully endorsed by the writer.

Your condemnation of a road's permitting its engine-runners to ignore the signals of a block system is timely and good. It recalls a similar incident that came under the writer's observation a few months ago on a suburban electric railway in this vicinity. No attention being paid to a red-light signal at a turnout, inquiry was made in regard to the reason for ignoring it, and the reply made that it was out of order and instructions had been given to disregard it.

To the average layman it would appear much more sensible to dispense with the signal entirely until it could be put in order than to inculcate in the slightest degree disrespect for a danger signal whose warnings should never be disregarded. Very truly yours,

John C. Chase.

Derry, N. H., Feb. 9, 1903.

Block Signals on the Philadelphia & Reading R. R., and Why Engineer Davis Failed to Obey Them.

Sir: In your editorial in reference to the recent wreck on the Central R. R. of New Jersey, near Plainfield, you note that the engineer may have been confused by traveling over part of the line without signals. I would inform you that the Reading system has had "Hall" signals in operation from Philadelphia to Bound Brook for about 2½ years, and on a part of the distance for about eight years. Engineer Davis, whom I knew as an employee when I was an assistant trainmaster on the Reading system, was perfectly familiar with signals of both types (the Hall and the Union Switch & Signal Co.'s electro-pneumatic), he having been an engineer running across the main running tracks.

The inclosed letter, published in the Philadelphia "North American," may present some matter of interest. It is a fact that engineers do run by signals, for I have personal knowledge of this being done.

Yours truly, H. D. F.

New Jersey, Feb. 17, 1903.

(We print the following extracts from the clipping enclosed.—Ed.)

From the time when a prospective engineer enters the employ of a railroad as a green fireman on the extra board in freight service, he has indelibly impressed on his mind the Jersey Central rule, and the rule of all roads—in fact, that a red signal of any kind is an imperative order to stop, and to all railroad men the disregard of this red signal is a more serious offense than that of murder itself.

It is only logical to presume, certainly from a railroad man's standpoint, that Mr. Davis did not see the signals against him. Accepting this premise, it is equally logical that for a few moments preceding the accident his attention was drawn from his customary close observation in the direction which his locomotive was moving.

Supposing that, while running on schedule time, which may have been fifty or sixty miles an hour with this train, a sight feed glass should burst on the lubricator. With the steam filling the cab and the oil pouring down the side of the boiler, the first impulse of the engineer would be to shut off the steam from the lubricator. While thus protecting himself from being burned, the engineer might employ one, two or three minutes. His attention thus distracted, might cause him to pass at that rate of speed through almost two blocks on the line.

Or, supposing that his injector, then engaged in supplying the boiler with water from the tender, should "fly off" or cease its action. In order that the boiler would not be scorched, it is imperatively necessary that the action of this instrument should be maintained, and no matter how closely an engineer might be watching the road ahead, the moment this occurred he would at once proceed to put the injector to working properly. This also might consume two or three minutes, and the steam escaping out of the overflow might obscure the track ahead or sweat the glass in the front door of the cab so that the line could not be seen clearly.

These are common failures of a locomotive. They have occurred untold times to every engineer in service to-day.

If this accident could be sifted to the bottom it is my opinion that some explanation such as above would materialize. The first instinct of the engineer is to look after the safety of his train, but there is another instinct to protect the valuable property in the shape of the engine entrusted to his management, and it might be that the latter would momentarily prevail over his better judgment. Very truly yours,

Robert H. Rogers, American Locomotive Co.

Richmond, Va., Jan. 31, 1903.

(From the engineer's ante-mortem statement it appears that the engineer was at work on the injector trying to restart it when he passed the block signals at danger.—Ed.)

An Analytical Method of Determining Illumination.

Sir: In reading the interesting article on "The Improvement of Interior Lighting" in your issue of Dec. 11, I note your quotation from Professor Smith's paper on "Method of Determining the Illumination on a Surface." It may be of interest here to note the analytical method of reaching the same results, as this method is more direct, easier to obtain and also more convenient to use in calculations.

In Fig. 1, reproduced from a working drawing, let A C B represent the candle-power curve of the source of light drawn to any convenient scale. (The use of a hundredths scale is simple and easy.) The height O R = h of the light above the plane to be illumined and the distances on this plane from the foot of the perpendicular below the source of light, are drawn to any convenient scale. If we are considering the amount of illumination falling on a horizontal plane, we have at any point:

$$I_h = \frac{(c.\ p.)\cos\phi}{d^2} = \frac{(c.\ p.)\cos^3\phi}{h^2},$$

where ϕ is the angle between the ray and the perpendicular, d the distance from the source of light to the point in question and (c. p.) the candle-power = O C. We can thus obtain the values of I_h for a number of points, from which the distribution curve can be plotted, the ordinates being in candle-feet and the abscissæ in feet. It is most convenient to prepare a table as shown. If the candle-power curve is laid off with a hundredths rule, the different values of candle power can be obtained at once by simply measuring the lengths of the lines intercepted by the candle-power curve. The values of ϕ are obtained at one setting of a protractor, and the values of $\cos^3\phi$ can easily be obtained by a table of cubes once for all. The work in general does not allow of greater accuracy than 1°, but the values of $\cos^3\phi$ for half degrees can be obtained by interpolation where necessary. It is thus possible to obtain an accurate horizontal distribution curve in about a half hour's work ($\cos^3\phi$ being already calculated) but the chief value of the curve is to show graphically the decrease in horizontal illumination at increasing distances from the light. For calculation the table is more convenient, intermediary points being obtained by interpolation.

As the values of the illumination I_h are in one plane, it is possible to add them arithmetically. Thus in Fig. 2 a flat desk at B would receive light from all six lights shown, and if the curve and height in Fig. 1 were those used, we would have, assuming all lights are similar:

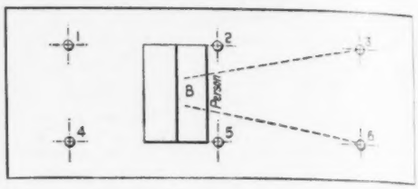
From light	1	.61	candle feet
" "	2	1.45	" "
" "	3	.34	" "
" "	4	.61	" "
" "	5	1.45	" "
" "	6	.34	" "
Total		4.80	" "

A person sitting at the desk would cut off the direct light from 3 and 6, and if it were a roll-top desk, 1 and 4 would throw no direct light so that only 2 and 5 would be directly useful. The amount of indirect illumination received in the latter case from lights 1, 2, 4 and 5 depends on the reflection from the walls, ceiling and floor and cannot be calculated except in a general way.

It is sometimes desired to light vertical surfaces, such as the walls of a picture gallery. In this case we have

$$I_v = \frac{(c.\ p.)}{h^2}\cos^2\phi\ \sin\phi\ \cos\theta,$$

where θ is the angle between the horizontal projection of the ray and the perpendicular to the wall.



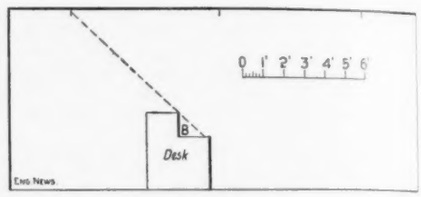


Fig. 2.

The curves shown in Fig. 1 can easily be used for any value of h. Thus, if a new height h' is used, we get the corresponding value of I_h as follows:

$$\frac{h}{h'} = \frac{d}{d'},\ \text{or}\ d = d'\frac{h}{h'}.$$

In our table, Fig. 1, we obtain the value of I_h corresponding to the value of d, which multiplied by $\left(\frac{h}{h'}\right)^2$ gives the value of the illumination for the same angle ϕ. With a slide rule this transformation is very simple and rapid.

I am very glad to note the increased attention which is being devoted to this branch of engineering, as its importance, both from the points of comfort and economy has been much underrated. Much attention has been devoted to the saving of a few per cent. in the cost of production of light, but the utilization of the same when once obtained has been largely neglected, although it offers a larger immediate field for practical economy than almost any other engineering problem.

Very truly yours, Van Rensselaer Lansingh.

18 E. Adams St., Chicago, Jan. 10, 1903.

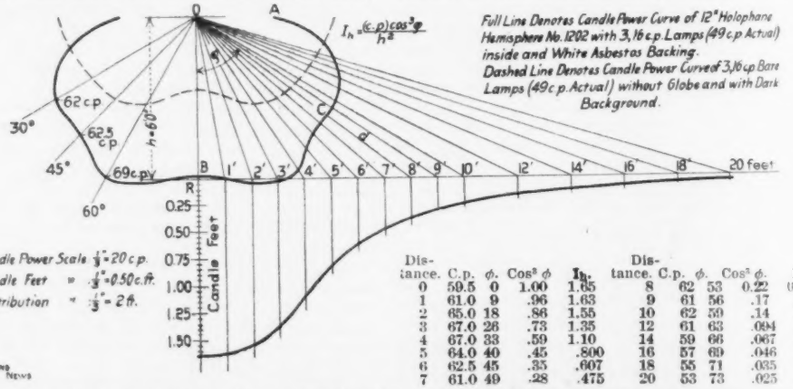

Full Line Denotes Candle Power Curve of 12" Holophane Hemisphere No. 1202 with 3,16 c.p. Lamps (49 c.p. Actual) inside and White Asbestos Backing.
Dashed Line Denotes Candle Power Curve of 3,16 cp Bare Lamps (49 c.p. Actual) without Globe and with Dark Background.
O
A
C
62 c.p
62.5 c.p
69 c.p.
30°
45°
60°
h=60"
B 1' 2' 3' 4' 5' 6' 7' 8' 9' 10' 12' 14' 16' 18' 20 feet
R
0.25
0.50
0.75
1.00
1.25
1.50
Candle Feet
Candle Power Scale 1/8" = 20 c.p.
Candle Feet " 1/8" = 0.50 c.ft.
Distribution " 1/8" = 2 ft.
Eng. News

FIG. 1. WORKING DIAGRAM FOR DETERMINING HORIZONTAL DISTRIBUTION OF LIGHT FROM A GIVEN SOURCE.

Distance.	C.p.	ϕ.	$\cos^3\phi$	I_h.	Distance.	C.p.	ϕ.	$\cos^3\phi$.	I_h
0	59.5	0	1.00	1.85	8	62	53	0.22	0.379
1	61.0	9	.96	1.63	9	61	56	.17	.288
2	65.0	18	.86	1.55	10	62	59	.14	.241
3	67.0	26	.73	1.35	12	61	63	.094	.159
4	67.0	33	.59	1.10	14	59	66	.067	.109
5	64.0	40	.45	.800	16	57	69	.046	.073
6	62.5	45	.35	.607	18	55	71	.035	.053
7	61.0	49	.28	.475	20	53	73	.025	.036

The Difficulties of Transition from the Present System to the Metric System.

Sir: Mr. Corthell's statement as to the utility of the metric system should be conclusive and end the controversy. I wish only to take up Mr. Trautwine's suggestion as to the difficulty of transition experienced by users. When I entered practical work 40 years ago in South Germany, I found the engineers using the foot divided decimally into inches, lines and points, while the balance of business people subdivided the same foot duodecimally, names being the same, so that you had to mind

whether decimal, or duodecimal inch, line or point was meant. Accumulations were more erratic yet, for we had a rod of 10 ft. and the klafter of 6 ft. The unit in mining work was the Lachter of 8 ft. Of cubical units we had the Kubic Klafter 126 cu. ft. and engineers on railway work used a perch of 25 cu. ft. Curvature in railway work was expressed by x feet radius. Two different pounds had to be guarded against; and to compute the weight of substances we had to remember the weight of water in either kind of pound.

After some years I had to work with another kind of pound and of foot, and had to run my curves per degrees subtended by a chord of 10 Klafters (a different length of the Klafter than I had known before). Then the metric system was substituted for everything we had known. Finally I came to the United States and entirely different units, subdivisions, etc., confronted me. My experience, therefore, should enable me to judge the difficulties to be overcome in such a change and my experience has been that an engineer—and apparently everybody else—will find little difficulty in dropping one system and in working in another. The difficulties only begin where you have to work two systems together, or more clearly stated, where you have to convert one system into another, as in cases cited by Mr. Corthell. To a person knowing no other system of numerals than the dekadik, the metric system should offer no trouble at all.

The defenders of a "bisecting" system are right, and no less a savant than Gauss recommended the adoption of the binal (or Chinese) system of numerals. Foolish arguments are excusable, too. A German professor of quite a scientific reputation argued for the retention of the duodecimal system, giving as prime reason the fact (?) that Jesus had twelve apostles. There can be no question that the duodecimal system would offer more advantages as to subdivision, but these advantages can only be realized by the use of the duodecimal system of numerals, and the question is, which it would be easier to introduce, the metric system of measures and weights or the dodekadik system of numerals.

The introduction of the metric system, as far as I can see, is only for the purpose of facilitating our scientific and commercial intercourse with the largest part of the commercial population on the globe. It is a money question pure and simple. I think that these interests will prevail no matter what some engineers, conservatives or jingos, may say or think, because the dollar is a very heavy argument. Personally, I may state, I find it immaterial in what system I work. And, as a matter of fact, there is no time lost to work in decimals of one foot and give directions to the mechanic in common fractions, if you have a mind, but there is plenty of grief ahead for you if you have to estimate and dimension work in one system after plans made in another system of measures and weights. But then, one of the prime principles in physics is that it takes a certain power to overcome the inertia of bodies, and this power already exists in our political and commercial world-power policy.

B. Schreiner.

Des Moines, Ia., Feb. 9, 1903.

The Metric System on Railway Construction Work in Mexico.

Sir: I have seen boomerangs thrown that described two circuits and ultimately hit the object aimed at.

"It is a condition and not a theory," described in my letter published in your issue of Jan. 15, which obtains in Mexico relative to the use of the metric system in railway work.

The condition is that the 20m. station, and the stake numbering is used as I described them, and not that "which may be simplified(?) by using 10-meter stations with two stations per chain." Taking cross-sections at the stations would necessarily double the work, and the benefit of the factor 20 in the calculation would then be lost.

Cubic contents, by method of end areas in 20m. stations, are obtained by adding end areas and moving the decimal point one place to the right, not as Mr. Miles says (Eng. News, Feb. 5) to the left.

The same simplicity of calculation is true of the American method, for cubic feet, when the cross-sections are taken 20 ft. apart, with this added advantage that when the ground is rough enough to permit of taking prismoids of 20 ft. length, the foot system is simplified and the metric is complicated. In short, the metric system has no advantage whatever in figuring quantities of plus stations.

This feature of simplicity in the calculation of quantities with a length of 20 ft. is not peculiar to the metric system but is due to the coincidence of the length of the station finally adopted.

Before the metric system was made compulsory in railroad work, engineers of the different nationalities used the system in vogue in their own countries. The Americans used the 100-ft. station, and when the metric system was made compulsory, they tried and did use, for a while the 30m. station, but adopted the 20m. station, not because it was the most economical length, but because of the simplicity occasioned by the use of the factor 20 in earthwork calculations, as a partial recompense for the 33% loss of time and increase of labor in the field, caused by the use of a station 20m. long (66 ft. approximately) instead of 100 ft.

As to the factor 5,280 entering into stake marking, either on surveys or construction, I never heard of it on up-to-date railroads. Its use is entirely superfluous. Yet, with the 20m. station, kilometers are found by dividing by 500.

Every engineer desires the decimal system, but not necessarily the metric decimal. The foot decimal meets all the requirements of railroad work as well as other works of the civil engineer, and for the same number of decimal places, gives much more accurate results.

The United States and Great Britain, who, together, manufacture more; control more population, and have built more miles of railroad, with all that it implies, than all the metric-using countries, and who, as the statesmen of to-day predict, will dominate the world, are certainly able, and ought to build upon the foot and pound, with Latin nomenclature if desired, a decimal system of measures and weights, that would not materially disturb those that are, for them "irrevocably tied to the past."

And this, too, can be accomplished without reference to "wigs," "oysters," "ruts," and other invidious comparisons.

Yours respectfully,

A. S. Robinson.

St. Ignace, Mich., Feb. 12, 1903.

The Metric System in Railway Work.

Sir: Although it is distasteful to me to take part in a discussion which can be of very little practical usefulness as to the advantages and disadvantages of the metric system still I feel it incumbent upon me to correct some errors which appear in one of the letters on this subject published in Engineering News of Jan. 15, 1903.

From your correspondent's assertions in that letter I should judge that he never actually used the metric system on railway work in Mexico, or elsewhere, and that he has therefore misunderstood something that was told him about stationing and grade percentages. His remarks about these basal elements of railway work are so distinctly different from the practice with which I have been familiar during an experience extending over more than 20 years, both on railway and on private work, that I can account for them only in this way.

It may be, as your correspondent says, that the 20-meter chain seems an anomaly, but it is only seemingly so. For, since a chain of 100 meters is too long and one of 10 meters too short to be handled conveniently, 10 meters is made the base for stationing and the measurements are made with a chain 20 meters long; thus the decimal idea is retained, as is not the case with the 25-meter chain, for we use two-tenths or one-fifth of 100.

The stakes at the end of each 20 meters are then numbered with the even numbers, 2, 4, 6, 8, etc., and any "plus" measurement greater than 10 meters from the preceding even-numbered stake is recorded as a station with an odd number plus (+) the number of meters over ten. Thus in the instance given in the letter referred to, the point to which the measurement extends is 17.25 meters beyond stake number 5,150 (not stake number 2,575) and is recorded as station 5,151 + 7.25 (by this system it would be impossible to have a station 2,575 + 17.25); it is therefore only necessary to drop out the plus sign in order to read the correct distance in meters.

In some cases, particularly in the early days, when our experience with the metric system was small, 100-meter stations were used, the stakes being marked 0 + 20, 0 + 40, 0 + 60, 0 + 80, 1, 1 + 20, etc.; but this method being found rather inconvenient was generally abandoned and the first adopted. But never, to my knowledge, nor on large work, was the method adopted of marking the stakes continuously.

From the above it naturally follows that grades are expressed in true percentages of the distance. I have been connected with the location, construction and maintenance of several hundred kilometers of railway in Mexico and the grades were invariably expressed in true percentages; a 1% grade meant just what it said, one meter in one hundred, or 1-100 of 20 meters equal to 2-10-meter in one "chain" of 20 meters, and not, as your correspondent says, two meters in one hundred. I cannot imagine how he got such an idea.

For running curves by the method of deflection angles the 20-meter chain was adopted as the unit chord because by its use was avoided much trouble from those annoying and distracting decimals of a degree with which every engineer using the foot system has to struggle.

In the calculation of volumes by average end areas the metric system is much preferable to the foot unit. There is no division by 27. Moreover, with the 20-meter chain and a section taken at every stake it is only necessary to add the two end areas and then move the decimal point one figure to the right to obtain the volume in cubic meters.

There was some trouble with carpentry and masonry work for railways because the foremen, being generally from the United States, were unable—for reasons best known to themselves—to use anything but feet and inches, but in private work, where native artisans were employed, they preferred and used only the metric system. Shortly after the law making the use of the metric system compulsory went into effect, thinking that it might be clearer to explain work to these artisans by the use of the units with which they had been familiar all their lives, I sometimes used the ordinary old measures ("which tie us irrevocably to the past"), and almost invariably was corrected by the man who expressed himself in meters, etc., although he might have been without shoes on his feet.

It cannot be denied that much confusion exists, particularly in the hardware and similar trades, because the manufacturers of the United States sell their wares, made by the feet system, to the Mexican merchants, and therefore it is necessary to buy so many meters of 1½-in. round iron or so many kilos. of 2-in. nails; but for most other commodities the metric system is used. The women buy so many meters of dress goods, so many liters of milk, so many kilos. of meat, and this although the metric system has been in use a very few years and the persons thus using it are not scientists, but common people.

One, and perhaps the principal, cause of the opposition to the metric system seems to be the idea, which its opponents cannot shake off, that they must think in one unit and express themselves in another. This is a great mistake. We must think and talk in the same unit exactly as when using two languages. He who thinks in one language and tries to utter those thoughts in another can never talk fluently. The thought and the speech must go together spontaneously, as they will after a little practice.

In conclusion, I think I can safely say that no one who has ever used the metric system constantly in actual work will return voluntarily to the use of the foot system.

Yours truly, Caspar Wistar Haines,
M. Am. Soc. C. E.

Philadelphia, Pa., Feb. 2, 1903.

The Metric System: A Big Job for a Literary Engineer.

Sir: The metric advocates are in the habit of saying that the transition from the English to the metric system of measurement will be quite easy. All we have to do is to throw away our two-foot rules and other antiquated instruments of measurement and begin using the metric rule and other instruments derived from it.

This might be true enough if all we had to do was to change our measuring instruments. It would be just as easy to measure a piece of land with a steel tape divided into meters and centimeters as with one divided into feet and inches, and just as easy to find the diameter of a rod with a micrometer reading to .01 millimeter as with one reading to .001-in.

The metric advocate has also been saying lately that there would be no trouble in preserving our existing standards which are based on the inch. All we would have to do would be to give them different names, expressing them in the nearest integral number of millimeters. Thus a 1-in. hole would be called 25 (not 25.4) millimeters, and a 2-in. hole 51 (not 50.8) millimeters.

It is not worth while to argue this point with the metricist. It is a mere matter of opinion, which is not likely to be changed by mere argument. But there are two serious objections to the adoption of the metric system by the nations using the English units which the metric advocates never argue. They pass by them on the other side. These objections are: (1) That the millions of people in the United States and England have stored in their memories facts and figures which are based on the inch as the unit of measurement, and they can neither forget them nor mentally translate them into metric units. (2) That every book, newspaper, trade journal, trade catalogue, etc., which they are in the habit of reading or referring to is printed in the English language, and the English system of measurement is part of this language.

Without referring further to the question of memory of facts and figures based on the inch, let us consider a little the literary question:

In Russia or Turkey it might be decreed by the Czar or the Sultan that from and after a certain future date no book, newspaper or other publication should make any mention of any measurement that was not a metric one, under penalty of imprisonment or the bowstring. There would instantly be a literary "boom," so far as such a thing is possible in these countries, and the authors and printers would at once begin to produce a new collection of books, papers, etc., for the use of those who had anything to do with making or using measurements. All measurements thereafter made and published would be metric, and all books containing measurements, which were worth translating, would be translated into the metric system.

But such a decree could not be made in any Anglo-Saxon country. The reform (?) could only be made by the consent (silence gives consent) of the majority of the representatives of the people, and it could only be made gradually. The people would gradually be educated in the new system, and there would be a gradual change in the literature. During the transition period, which might last fifty to a hundred years, there would be two kinds of measurement literature produced and studied, (1) transition literature, (2) metric literature. The transition literature would have both the English and the metric systems on the same page or on adjacent pages. Thus, under the head of electrical wiring we would have two tables of resistances of different metals, with headings as follows:

French: Specific resistance in microhms-centimeters; resistance of 1 meter weighing 1 gramme; resistance of 100 meters of 1 mm. diameter.

English: Specific resistance, copper = 100; resistance in ohms per mil.-foot.

We would also have tables of resistances, etc., of copper wires, with the following headings:

French: No. of the decimal gage, diameter in millimeters, section in mm.², weight in grammes per meter, resistance in ohms per kilometer, length in kilometers per ohm.

English: American wire gage, Birmingham wire gage, diameter, inches; area, circular mils.; weight, lb. per ft.; weight, lbs. per ohm; length, ft. per ohm; length, ft. per lb.; resistance, ohms per lb.; resistance, ohms per ft.

Together with these there would be a set of conversion tables for converting lbs. per ft. into kilogrammes per meter, ohms per kilometer into ohms per ft., etc.

Then we would have two different steam tables, five lines of each of which would appear as follows:

a.	b.	c.	d.	e.	f.	g.
1.0	99.09	99.58	636.72	537.15	1.701	0.587
1.1	101.76	102.28	637.54	535.26	1.555	0.643
1.2	104.24	104.79	638.29	533.50	1.433	0.697
1.3	106.55	107.14	639.00	531.86	1.329	0.752
1.4	108.72	109.34	639.66	530.33	1.239	0.806

a. Pressure (absolute) kg. per sq. cm.
b. Temperature, °C.
c. Heat of the liquid.
d. Total heat.
e. Heat of vaporization.
f. Volume, cu. m. per kg.
g. Specific weight, kg. per cu. m.

h.	i.	j.	k.	l.	m.	n.	o.
0	14	212	180.9	1,146.6	965.7	26.36	.03794
0.304	15	213.0	181.9	1,146.9	965.0	25.87	.03868
1.3	16	216.3	185.3	1,147.9	962.7	24.33	.04110
2.3	17	219.4	188.4	1,148.9	960.5	22.98	.04352
3.3	18	222.4	191.4	1,149.8	958.3	21.78	.04592

h. Gage pressure, lbs. per sq. in.
i. Abs. pressure, lbs. per sq. in.
j. Temperature, °F.
k. Total heat above 32° in the water.
l. Total heat above 32° in the steam.
m. Latent heat in the steam.
n. Volume, cu. ft. per lb.
o. Weight, lbs. per cu. ft.

Under the steam tables it would be explained that pressures of steam in metric countries are commonly expressed in atmospheres, but that modern writers express them in kilograms per centimeter, and that 1 kg. per sq. cm. is nearly, but not quite, an atmosphere. A conversion table would be given in style something like the following:

1 atmosphere = 14.697 lbs. per sq. in. = 29.992 ins. (760 mm.) of mercury = 1.033296 kg. per sq. cm. 1 metric atmosphere = 1 kg. per sq. cm. = 0.96777 atmosphere = 735.51 mm. (29.025 ins.) of mercury.

The metric literature would be much simpler, thus:

1 atmosphere = 760 mm. of mercury = 1.033296 metric atmosphere = 1.033296 kg. per sq. cm. 1 metric atmosphere = 1 kg. per sq. cm. = 0.96777 atmosphere.

This little conversion table is necessary because there are two atmospheres used in the French system, one the actual mean pressure at the sea level, or 1.033296 kg. per sq. cm., and the other an ideal atmosphere, in which there is "the beautiful correlation between measures of length and of weight," viz., exactly 1 kg. per sq. cm.

It would not be much of a job to produce the metric literature, for it would be necessary only to reproduce the rules, tables, formulæ and data now printed in the metric countries. There would be no tables of structural shapes, for instance, ranging by even inches from 3 to 24, with their corresponding weights per yard, and coefficients of strength in pounds, but there would be other tables in which there would be structural shapes from 80 mm. up to, say, 600 mm., advancing by intervals of from 20 to 60 mm., with their corresponding weights in kg. per meter, and with coefficients rorresponding to metric measures of length and weight.

The big job, however, would be to produce the literature of the transition period. It would include, in the tables of beams, for instance, all the existing standard sizes, in even inches of depth, with their corresponding metric equivalents to the nearest tenth of a millimeter, together with the dimensions, both English and French, of length, breadth of flange and thickness of web, the weight per yard and per meter, in pounds and kilograms, and the coefficients for computing strength in both systems. Besides this there would have to be new tables of the new sizes, 20 to 600 mm. in metric measures and in their English equivalents.

During the transition period the mechanical articles in the Encyclopædia Britannica and all other cyclopædias and other works of general reference would have to be reprinted in the transition language, otherwise they would not be readable by the people of the period. When the reform (?) was at last accomplished they would have to be reprinted again, making them altogether metric, and then the old books would all find their way to the paper mill.

The engineer's pocket-books would also have to be reprinted in the transition language, and then many years later completely metricised. If it is true, as the metric advocates so confidently assert, that the reform is surely coming, and coming very soon, it is time that the authors of these pocket-books and their sons and grandsons were preparing for it. There will be work enough cut out for them to last at least three generations. It should be highly profitable, too, for every present owner of one of these pocket-books, if the metric system is coming very soon, would have to provide himself with both of the new books, and the transition book would be at least half as large again as the present book, and of course would sell at a higher price. The first editions also would have so many typographical errors and errors of computation that the new editions would sell rapidly.

To get an idea of the size of the job that will have to be done if the impending reform is accomplished, let us consider some of the tables, etc., that are found in these books based on the English inch. They are:

Wire and sheet-metal gages.
Weight and specific gravity of substances.
Weights of standard sizes of bars, rods, tubes, structural shapes, pipes, fittings.
Thickness of pipe for different pressures.
Standard pipe flanges, boiler tubes, riveted pipe, brass, copper and lead pipe.
Standard sizes of screw threads, taps, set screws, machine screws, nuts, bolts, rivets, washers, nails and spikes, wire, wire rope, cables, chain, fire-brick.
Strength of materials, rules, tables, formulæ, etc.; safe loads on columns, beams, shafts, bolts, bursting pressure of pipes, cylinders, boilers; results of tests of materials, bars, chains, springs, riveted joints, timber, alloys, ropes, wire ropes.
Specifications of all materials.
Velocity of falling bodies, height due to velocity.
Air, properties of, compressed air, tables and formulæ, flow of air in pipes, air compressors, fans, blowers.
Heating and ventilating, formulæ and tables.
Water, weight, pressure, flow, pumps and pumping engines, turbines.
Steam, properties of, steam pipes, boilers, chimneys, heaters, engines, condensers, flywheels, governors.
Transmission machinery, gear wheels, shafts, pulleys, belts, rope, wire rope.
Foundry and machine shop practice.
Refrigerating machinery.
Locomotives, cars, railroad work.
Marine engines, ships, etc.
Electrical engineering.

The list might be extended indefinitely.

Another branch of technical literature that would have to be reprinted is that issued by the several correspondence schools. The hundreds of thousands of students of these schools would all have to be furnished with instruction papers in the transition language. The instructors in the schools also would have a big job added to their present one in correcting the additional errors made by their pupils on account of their want of familiarity with the new units of measurement.

It may be said that the transition literature would not be needed, that a good book of conversion tables would fill all wants in transposing from one system to the other. But as long as manufactured articles, such as bars, tubes, etc., are made in standard sizes by the English system, so long would we require tables of weight, capacity, etc., of these sizes, and such tables cannot be converted from one system to the other without great labor and liability to error. The use of printed tables giving the weights, capacities, etc., in the French system, together with the sizes in English measures, would be needed. Just such tables are already found in catalogues of American manufactures, printed in French and German. There is a table of this kind in a French book of "Notes and Formulæ," 1897 edition, giving weights in kilograms of cast-iron pipe, the sizes of which are given as follows:

Inches	1¼	2	2½	3	3½	4	5	6	7	8
Millimeters	41	54	67	81	94	108	135	162	189	216

On another page there is another table of weights of other sizes of pipe, viz.:
Millimeters, 40, 50, 54, 60, 70, 75, 80, 90, etc.

The first table represents the sizes of pipe that would be made during the transition period; the second the sizes that would be made when the metric system had been completely introduced.

The same book gives a table of screw-threads "Systeme Whitworth," with the following figures:

Diam., ins..	¼	5/16	⅜	7/16	½	⅝	¾	⅞	1
Diam., mm.	6.35	7.94	9.52	11.11	12.70	15.87	19.05	22.22	25.40
Thr'ds pr in.	20	18	16	14	12	11	10	9	8
Pitch, mm.	1.27	1.41	1.59	1.81	2.11	2.31	2.54	2.82	3.18
Diam. core*	4.72	6.09	7.36	8.64	9.91	12.92	15.74	18.54	21.33

*Millimeters.

The book says of the Whitworth system, that it has been adopted for a long time in England and in Germany: "It is very desirable that we reach some universal rules for the pitch of screws, but the widely extended use of the Whitworth sizes prevents it, until England has adopted in practice the metric system."

So it appears that even in France, after more than a century of the metric system, the transition period of mechanical literature is not yet at an end.

The conclusion from the above study of the literary question is that the work to be done in converting the English-speaking race from the English to the metric system is so appalling in its magnitude that it can never be done at all. There will be no transition period and no transition literature. There may be laws passed making it "the" legal system, and the departments of the government may be compelled by Congress to use it in all business transactions, but the people as a whole are no more likely to adopt it than they are to give up the English language and adopt French in its place.

Very truly yours, M. Am. Soc. M. E.

New York, Jan. 26, 1903.

Notes and Queries.

A. J. S., Philadelphia, Pa., wishes to purchase a water motor to develop about 1 HP. and work against a back pressure of about 20 lbs. He thinks a motor designed on the principle of a water meter would fill the bill, and desides to know if such motors are manufactured.

A. A. H., Reno, Nevada, wants us to use the words "headlision" and "rearlision," which he has coined to describe the two classes of railway collisions. We see no advantage in such terms. "Butting Collision" and "Rear Collision" are in common use, and are understood by everyone, which would not be the case with any word newly coined.

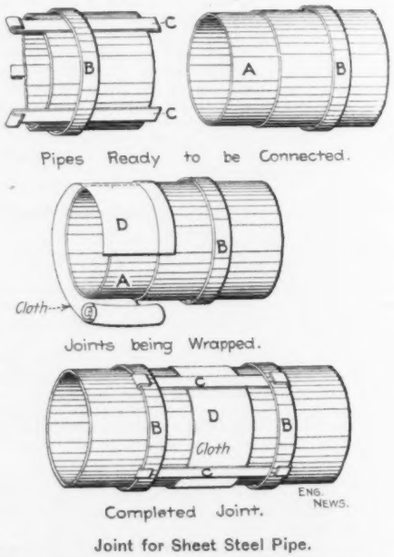
R. L., Burke's Station, Va., writes that he proposes to build a concrete arch of 50 ft. span to carry a double-track embankment 40 ft. high, and inquires whether, as there will be no appreciable bending moment in the arch ring, there would be any advantage in embedding steel rails in the concrete. If it were desired to use the rails merely to aid the concrete to resist the compressive strain; would the smooth rail having no projections to bond with the concrete be effective for this?

We see no advantage in the use of steel with concrete under such conditions, or at least no advantage commensurate with the additional cost. We should be glad to hear from any engineers, however, who can give good reasons for a different opinion.

A JOINT FOR GALVANIZED STEEL PIPE.

Sheet metal pipe is very extensively used for conveying water long distances for irrigating or mining purposes, and also for drains, exhaust, suction and discharge pipe, well-casing (where only light driving is necessary), and various other purposes. The accompanying cut shows a form of joint for galvanized steel pipe of this class, and used principally for water and ventilating pipe in mines. The pipe is made in 10-ft. lengths, each length rolled from a single sheet. The longitudinal seam is a single-riveted seam for sheets of No. 16 gage, and a lock seam for pipe made of sheets of No. 18 and No. 20 gage. Pipe is made from black sheets in the same way, but must be treated with asphalt to be watertight.

The pipes are put together with slip joints, one end of each pipe being reduced in diameter (as shown at A) to slip into the end of the next pipe. On each end of each pipe is also riveted a collar



Joint for Sheet Steel Pipe.
Tallerday Steel Pipe & Tank Co., Waterloo, Ia.; Makers.

B, with space between it and the pipe to admit the clips C. In making the joints, cloth is cut in lengths sufficient to wind three times around the pipe, and a sufficient length to go round once is dipped in melted asphalt and tightly wound, as shown at D. The pipe ends are then shoved together. The remainder of the cloth is coated with asphalt on the inner side with a brush and tightly wrapped around the joint, after which the clips are driven through the collar and the flat ends bent over, as shown in the view of the completed joint.

This joint is a specialty of the Tallerday Steel Pipe & Tank Co., of Waterloo, Ia., and we are indebted to that company for drawings and other information.

ELECTRICITY VS. THE LOCOMOTIVE FOR TRUNK LINE RAILWAY SERVICE.*

By C. F. Swelgert.†

To the traveling public the idea of being hurled across the continent in an electrically-driven train at a speed of 100 miles an hour is a very seductive prospect, but to those more or less familiar with the difficulties it is yet an iridescent dream.

The number of long-distance electric transmissions installed in the past few years, transmitting power economically and commercially, for distances up to 150 miles, has led some people to believe that electricity on trunk lines is in sight. This, however, is an erroneous impression, due primarily to the fact that long-distance transmissions are of necessity very high-tension alternating currents, while the successful railway motors are invariably low-tension, and of the direct-current type.

In order to use high-tension alternating currents for railway work, it has been necessary to interpose both static and rotary transformers, and this, of course, very greatly increases the expense, both in original investment and in operation, since these transformers must be located in substations at more or less frequent intervals along the line.

As a little extension into the field of possibilities, I asked my friend Mr. Graham for some figures on the motive power on the 400 miles of the Oregon R. R. & Navigation Co.'s line, between Portland and Huntington. Trying to displace this power with electricity is a good deal like attempting to realize the distance to the sun, but, roughly speaking, it would require four main generating stations, with a combined capacity of probably 40,000 HP., and costing probably $6,000,000 to install. It would also require at least 20 substations, each with a capacity of at least 3,000 HP. to take care of the concentrated loads, and costing at least $6,000,000 more, or $12,000,000 in station equipment alone. The feeders to convey the necessary current along the line would probably reach a sum nearly, if not quite, $5,000,000, or, say $17,000,000 for power and line.

Electric locomotives of a capacity equal to the present steam locomotives would involve an additional expenditure of something like $750,000, or a grand total of nearly $18,000,000, to displace locomotives costing perhaps 3 or 4% of that sum.

When we consider that, with the greatest success possible in the present experiments, at least one-third this sum would be required, we must conclude that trunk-line electric transportation is like express service to the moon—interesting, but improbable.

As a matter of fact, unless some heaven-born genius is sent us to entirely revolutionize present methods, electricity is absolutely out of the race for long-distance work; and, while some experimental roads using alternating-current motors are in existence, or building, there is no particular reason to suppose that the problem is any nearer solution to-day than it was five or even ten years ago.

*Extract from a paper read before the Pacific Coast Ry. Club, Jan. 17, 1903.

†General Manager City & Suburban Ry. Co., Portland, Oregon.

THE GREAT MAGNETITE DEPOSITS OF SWEDEN.

The completion of the Arctic Railroad from Lulea to Victoria Haven marks an epoch in the history of iron mining in Europe. This railway is 230 miles long, of which 130 miles lies north of the Arctic Circle, and having been built by the Governments of Norway and Sweden, will now be turned over to the company owning the mines. This company is to keep the railway in repair, and turn over annually to the two Governments a percentage on the first cost of the line.

For 15 years trains have been running to the famous iron mines at Gellivare, a town of 6,000 inhabitants, which is 44 miles north of the Arctic Circle. These mines yielded a million tons of ore in 1900; the miners receiving $1.40 to $1.75 a day.

There will now be developed a much larger deposit of iron ore at Kirunavaara on the line of the new railway. This deposit is a mass of magnetic ore forming a ridge about 700 ft. high and several miles long.

It is estimated that there are 200,000,000 tons of this ore available; and if 2,000,000 tons are annually mined it will evidently take a century to exhaust the ore in sight. A town of some 15,000 people is expected to occupy what is now a solitary waste fronting this hill of iron.

Victoria Haven has been fitted with up-to-date harbor facilities; the ore dock comparing favorably with those of Lake Superior in size and effectiveness.

It is interesting to note that while the United States Steel Co. is acquiring control of the iron lands of Lake Superior with a view to controlling ore deposits, other vast iron deposits are being developed not only in this country but abroad.

THE SCHWARZ DRYING AND MIXING MACHINE FOR MANUFACTURING LIME-SAND BRICK.

The characteristic features of the process of lime-sand brick manufacture, invented by Mr. Wilhelm Schwarz, of Zurich, Switzerland, are: (1) The exact control of the heat and moisture required for the cementing action; (2) the protection of the mixture from atmospheric influences; and (3) the continuation of the cementing action throughout the processes of mixing, molding and hardening. The significance of these characteristics will be made clear by a brief explanation.

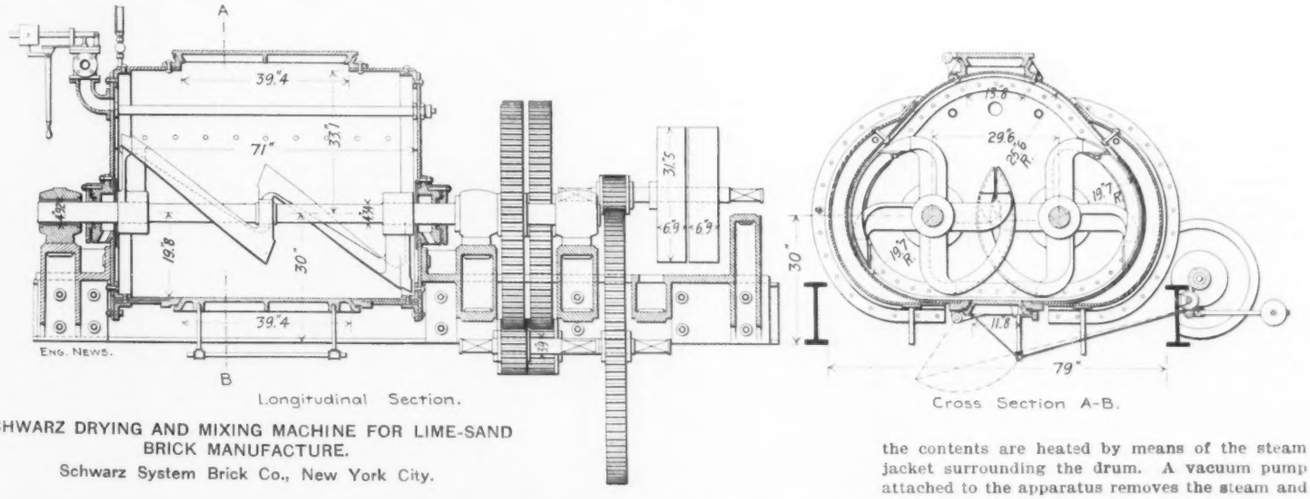
If quartz, sand and lime are mixed a chemical combination takes place between the two substances, with formation of silicate of lime, so long as the mixture is kept moist. This formation of calcium silicate tends with time to a thorough hardening of the mixture, if the latter is maintained under the influence of the moisture of the air. If the moisture is supplied in the form of steam the chemical action is accelerated, and it becomes particularly rapid when hot steam under high pressure is used. While calcium silicate is being formed, a simultaneous formation of carbonate of lime takes place through the action of the carbonic acid gas contained in the air. This secondary action is detrimental, since the calcium carbonate being to a certain extent hygroscopic, is attacked by atmospheric agents, which the almost insoluble calcium silicate resists perfectly well. Calcium carbonate is formed chiefly when the mixture is allowed to harden in moist air, since in such a case the chemical reaction between the sand and lime is very slow, and the carbonic acid of the air has plenty of time to enter into combination with the lime. On the contrary, in the steam hardening process the hardening operation takes place very rapidly and calcium carbonate has less opportunity to form. Based on this reasoning the process of lime-sand brick manufacture most approved by German authorities, by whom it has been devoleped to high commercial importance, is the steam-hardening process. In order to obtain a lime-sand brick of uniform good quality the sand must be mixed with just the quantity of lime necessary to produce the requisite amount of calcium silicate required for perfect cementation. If any trace of lime remains in a free state it is likely later on to combine with the carbonic acid of the air.

Summarized briefly, the theoretical requirements for the successful manufacture of lime-sand bricks of the highest quality are: (1) The careful proportioning of the sand and lime; (2) the accurate control of the heat and moisture; (3) the exclusion of the outside atmosphere; and (4) the acceleration of the hardening process. It was for the purpose of meeting these requirements as perfectly as possible that Mr. Schwarz developed the process and apparatus which are described below.

The first operation in the Schwarz process is the mixing of the sand and lime, which is done in a vacuum mixing machine. This machine is shown in transverse and longitudinal section by Fig. 1. Briefly described, the machine consists of a steam-jacketed drum with interior rotary blades operated by suitable gearing outside and at one end. This drum, which has a capacity of about three tons of sand, is filled by means of a funnel placed above it. When the drum is charged, the interior mixing blades are set in motion and the contents are heated by means of the steam jacket surrounding the drum. A vacuum pump attached to the apparatus removes the steam and air from the drum. When the sand has been properly dried the required quantity of finely pulverized lime is introduced into the drum through a special aperture and the mixture is again stirred and heated. The necessary quantity of moisture is then introduced into the drum in the form of water or steam by means of a pipe penetrating the interior of the drum. After wetting the mixture continues to be stirred and heated during a sufficient time to allow a preliminary combination of the lime and sand to take place, and produce a mixture with sufficient tenacity to permit of easy molding.

From the mixer the sand and lime mixture is run into a storage bin which feeds the brick press and is molded into bricks immediately. The bricks from the press are stacked on cars and run directly into a large cylindrical steel hardening chamber. This chamber is heated by steam pipes and kept moist by introducing sprays of water. In this chamber the bricks are completely hardened ready for use as soon as they are removed and cooled.

The Schwarz process of lime-sand brick manufacture is controlled in the United States by the Schwarz System Brick Co., of New York city, to whom we are indebted for the material from which our illustration has been prepared.



Longitudinal Section. Cross Section A-B.

SCHWARZ DRYING AND MIXING MACHINE FOR LIME-SAND BRICK MANUFACTURE.
Schwarz System Brick Co., New York City.

AN OFFICIAL RECOMMENDATION OF AUTOMATIC STOPS IN CONNECTION WITH BLOCK SIGNALS.

In the forthcoming annual report of the Illinois Railroad & Warehouse Commission, Mr. F. G. Ewald, Consulting Engineer to the Commission, takes strong ground in favor of the use of automatic stops or brake-setting devices in connection with block signals. We quote from the report as follows:

In my opinion, the number of killed and injured by collision could be diminished almost wholly, including many of the fatalities attributable to derailments, by the use of automatic block signals with attachments for automatically applying the train brakes. Such a system has been in practical use on an elevated railway in Chicago for some years, and another system of the same character has been installed within the last year or two on one of the elevated railways in New York city. [Boston.—Ed.] While I am not familiar with all of the devices for automatically applying the train brakes, the manufacture or design of these devices is not limited to one company; but there are as many as three companies or persons in the United States competing for this character of safety appliances.

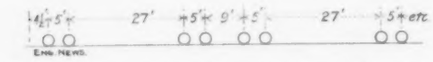


Fig. 111. Diagram Showing Wheel Spacing for Calculating the Manhattan Valley Viaduct.
(Load per wheel, 12,500 lbs.)

A German invention of a device of this sort gave excellent results in a trial test recently held and as a result of this demonstration, it is to be put to a practical test on sections of the German and Russian state railways. Taking these facts in connection with the efforts being made in our country, it would be strange indeed if an automatic system of this character could not be found that would be infinitely better than the system of operating trains by telegraph as now generally in vogue.

Accidents by collision are commonly the result of an engineman or conductor (or both) placing a wrong interpretation on telegraphic orders given them; or failure on the part of trainmen to carry out orders as given them; or failure on the part of a station operator to hold a certain train when directed by the dispatcher to do so; or the issuing of conflicting orders on the part of the dispatcher; or failure on the part of the enginemen to observe or obey a block signal set at danger; or failure on the part of an automatic signal to assume the danger position, without any compensating features in connection with such signal in the form of a device for automatically applying the train brakes. Some very serious accidents have occurred recently as a result of many of the causes above mentioned and it is not necessary to go out of our own state to find them.

During the year ending June 30, 1902, there was paid out by the railway companies (of Illinois?—Ed.) for injuries to persons, loss and damage and clearing wrecks, a total of $1,842,176. This enormous sum forms one of the items chargeable to operating expenses. It is probable that at least half of this sum is chargeable to "collisions" and such "derailments" as could not occur with the use of practical automatic appliances. In one year, this sum would pay for the installation of block signals of the character mentioned for a distance of 2,930 miles of single-track road, if these signals were placed 3½ miles apart. Furthermore, there would be no necessity for the use of derails in main tracks at interlocking systems where the train mileage of roads was such as to warrant the adoption of the system. Even without the automatic appliances for applying train brakes, the Chicago, Burlington & Quincy R. R. has for some time operated its trains over the double track between Chicago and the Mississippi River by the aid of manually operated block signals only, with good results, and without the use of the telegraph except in cases when instructions are necessary to block certain trains. Mistakes on the part of employees, even among those who have been in the railway service for many years, are excusable to the extent that the human mind is not infallible to error. In my opinion, the adoption of automatic devices referred to is entirely practicable for the purpose of operating trains in lieu of the telegraph system. It would result in the saving of many thousands of dollars expended annually on the part of railway companies for damages to persons and property, and would avoid the fatalities to hundreds of the traveling public and employees. If this method of operating trains is practical, why should there not be an effort made to give such a system a thorough test? If the demonstration proves what is claimed for it, why should there not be a general adoption of a system of this character on such road where the necessity for it is apparent?

THE CORONER'S VERDICT ON THE WESTFIELD COLLISION.

The verdict of the coroner's jury which has been investigating the collision that occurred on the Central R. R. of New Jersey on Jan. 27, rendered its verdict on Feb. 13. Among the members of the jury was Mr. Andrew J. Gavett, Street Commissioner and City Surveyor of Plainfield. Extracts from the verdict follow:

We believe that this collision was caused by the failure of the engineer, James N. Davis, to observe the following signals displayed to warn him of approaching danger:

First. The red lamp set on the ground at Cranford, which notified him to stop for orders.

Fourth. A red lantern swung by the rear brakeman of train No. 13 (this man claims that he was within about 30 yds. of the road crossing when the train No. 621 passed him); and finally the home block signal, showing red and green lights, which indicated that he must come to a full stop, as the track ahead was occupied. This signal is located 2,136 ft. from the warning signal. Although from the evidence we cannot find that the railroad company or any of the officials can be held criminally responsible, there are certain mitigating circumstances in regard to the action of the engineer which should be taken into consideration.

There is no doubt that there was an unusual amount of steam escaping from some part of the engine during the run from Jersey City to Westfield the night of the accident. This escaping steam, the engineer claims in his ante-mortem statement, obscured his vision so that he could not see the signals without shutting off steam. As the air was heavy, this steam settling around the engine was probably the cause of his not seeing the train order signal at Cranford, consisting of a red lantern placed on the ground, thus failing to receive the warning from the train despatcher that train No. 13 was on the track ahead.

Engineer Davis states that, finding it necessary for him to get at the injector, he missed a signal. This was probably the cautionary signal before referred to just west of the Westfield station, and, as it has been shown by actual experiment that at the rate of speed he was going at the time it would only take 40 seconds after passing Westfield to strike the rear of train No. 13.

The fire which occurred immediately after the collision and added greatly to the horrors of the wreck was probably caused by the explosion of the headlight and burning gases escaping from the tubes of engine when the smoke-box was broken in. However, there were two stoves in each of the two rear wrecked cars, which probably increased the rapidity of the conflagration.

We have carefully considered measures that should be taken to guard against the repetition of accidents of this kind, and would suggest close study of the following questions:

Is the traffic of this railroad greater than can be safely handled, considering the very large amount of high-speed service required; if so, what is the remedy?

Should not all stoves be prohibited, and all passenger cars be heated by steam from the locomotive?

Should not the headlights on engines be electric or something safer than a lamp containing a large quantity of oil, which, in cases of accident, is liable to cause fire?

Should railroads be required to provide another man in the cab, whose sole duty it would be to look out for signals?

Should not a stricter observance of the rules relating to signals be insisted upon by the railroad officials, this especially in regard to distant or green signals? While there is no evidence before us that these signals are not regularly observed on the railroads concerned in this collision, there is a general feeling that a laxity prevails in this matter all over the country.

Should not the railroads adopt, in connection with their automatic visual signals, some one of the automatic safety devices that are now in the market, which actually shut off the steam, apply the brakes and stop the train if the track is blocked or out of order? To arrive at a correct decision in these matters, which require a great deal of serious and expert study, we suggest that the legislature of the State of New Jersey, now in session, pass a bill providing for a State Railroad Commission, to be appointed by the Governor, composed mainly of disinterested experts or practical railroad men, who shall investigate the above questions and others of equal importance which may be brought to their attention.

Second. The distant, or cautionary block signal, a green light just west of the Westfield station, which gave warning that the block ahead was occupied.

Third. A red lantern swung back and forth across the track by the flagman at the Broad St. crossing, Westfield, 874 ft. from the last mentioned block signal.

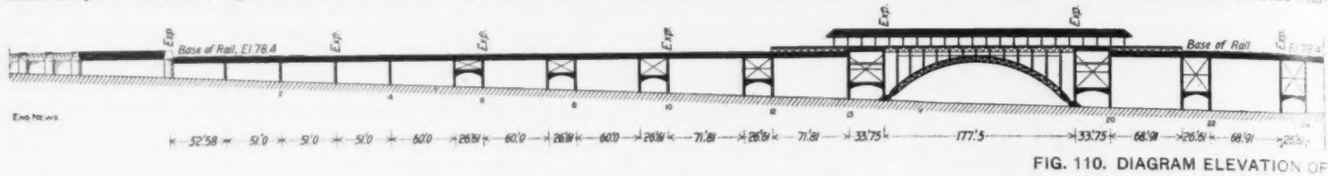


FIG. 110. DIAGRAM ELEVATION OF

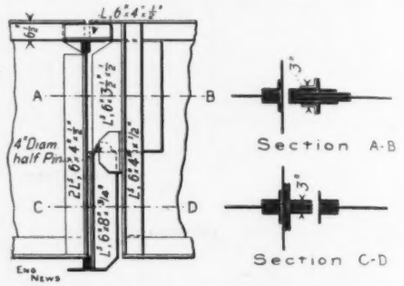


Fig. 113. Details of Expansion Joint Construction.

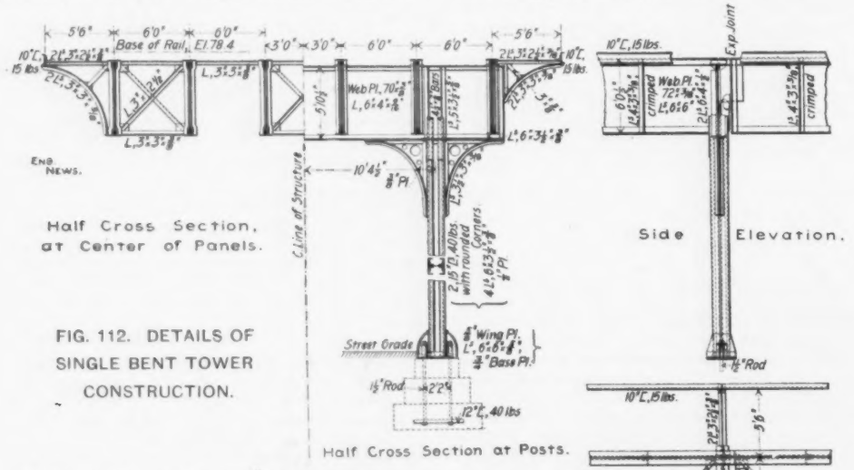


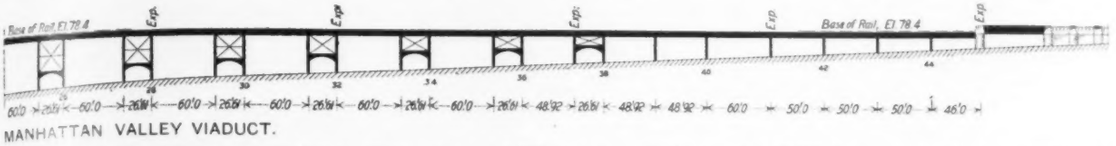
FIG. 112. DETAILS OF SINGLE BENT TOWER CONSTRUCTION.

THE NEW YORK RAPID TRANSIT RAILWAY.

XVII.

Contract Section XII.

Contract Section XII. of the Rapid Transit Railway extends from 125th St. to 133d St. Between these streets a deep valley in the profile of the



MANHATTAN VALLEY VIADUCT.

Boulevard rendered necessary a viaduct to carry the road. The subcontractors were E. P. Roberts for the foundations and the Terry & Tench Construction Co. for the erection of the steel work.

VIADUCT STRUCTURE.—Beginning at about 118th St. the profile of Broadway, which is the general route of the Rapid Transit Railway, descends on a rather steep grade to 129th St. and then rises on a similar steep grade to about 135th St. This depression is known as Manhattan Valley, and it forms the most pronounced cut in the high ridge of land which borders the west side of Manhattan Island for several miles of its length. To cross this depression a viaduct structure was necessary; consequently, the West Side Line emerges from subway just north of 122d St., and runs on embankment to 125th St., then on viaduct to 133d St., and then on embankment again to near 135th St., where the road again plunges beneath the ground. The viaduct structure constitutes Contract Section XII., and is shown in diagram side elevation by Fig. 110.

Referring to the diagram elevation it will be observed that the south approach embankment terminates in a masonry abutment at the south side of 125th St., and that a similar abutment begins the north approach embankment at the north side of 133d St. On the north side of 125th St., and on the south side of 133d St., are masonry piers. Between each of these piers and the adjacent abutment is a plate girder through span crossing 125th St. and 133d St., respectively. These piers were also the terminii of the viaduct construction proper. This was of the usual construction of plate girders carried on steel columns, except at one point, where the structure crossed Manhattan St., and here a two-hinge arch of 168½-ft. span was built. The reason for inserting this arch was to avoid an expensive readjustment of the junction of the surface lines of Broadway and Manhattan St., which would have been necessary had viaduct structure been used. The total length of the viaduct structure is 1,915 ft., and its total width is 41 ft.; it carries three lines of track.

The loads assumed and the unit stresses adopted in designing the viaduct structure were as follows: Live load, a continuous train of cars having the wheel spacing shown by Fig. 111 and a weight of 12,500 lbs. per wheel; dead load, track only, 330 lbs. per lin. ft. of track; wind load, 30 lbs. per lin. ft of structure; traction load, 20% of live load in either direction, flange stress, longitudinal girders over 27 ft., 10,000 lbs.; under 27 ft., 8,000 lbs.; transverse girders, 10,000 lbs.; floor beams, 8,000 lbs.; shop rivets, bearing 12,000 lbs. per sq. in.; shear, 6,000 lbs. per sq. in. The requirements for material, workmanship, etc., were those of the general specifications for subway and viaduct steelwork, which were published in Article III.

four parallel girders with webs 90 × ⅝ ins., and flanges of 6 × 6 × ⅞-in. angles. The floor beams have plate webs and double angle flanges and the stringers are rolled I-beams.

The four endmost towers at the south end and the six endmost towers at the north end of the viaduct where the elevation above the street is moderate are single bent towers, and their construction is clearly shown by Fig. 112. The columns, it will be noted, are made of channels with rounded corners, and are anchored to the bases with unusual security. Another feature of the design which deserves attention is the expansion joint.

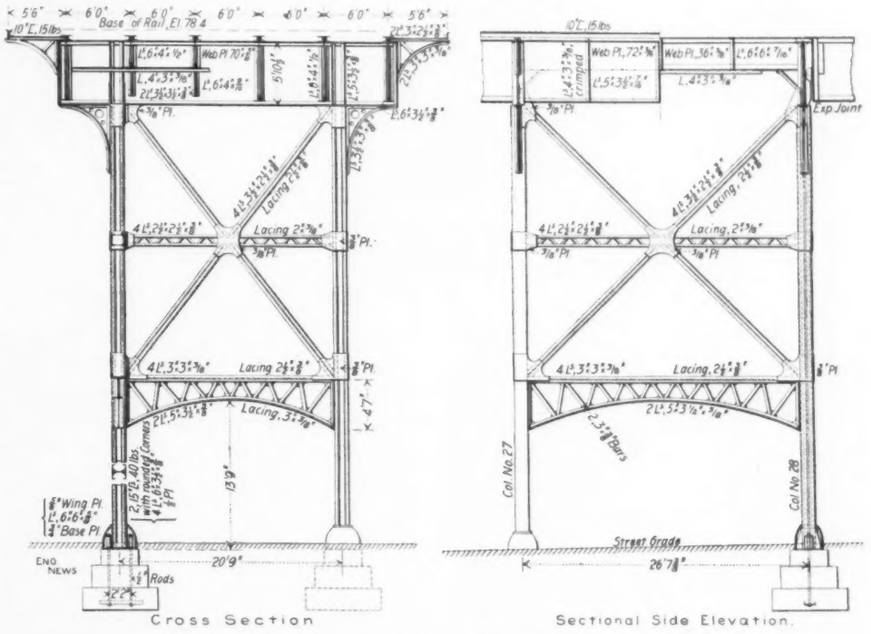
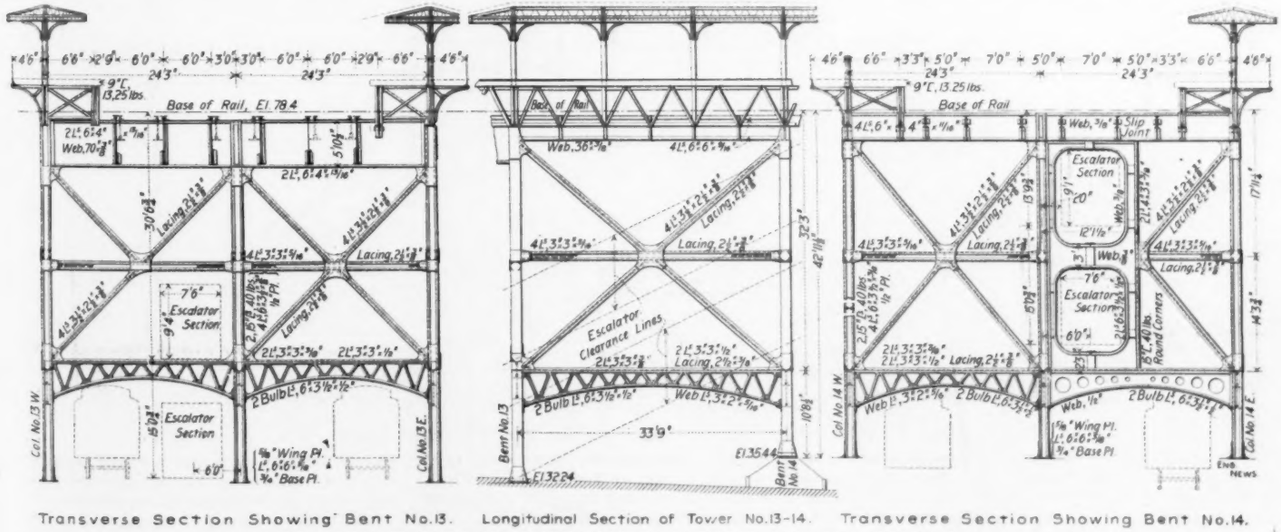


FIG. 114. DETAILS OF DOUBLE BENT TOWER CONSTRUCTION.

Taking up the structure in detail we have to consider first the end approach spans, second the viaduct construction proper, and third the steel arch span. The approach spans call for brief mention only. They are through plate girder spans of 86 ft. and 65 ft., respectively. Each span has

The spacing of these joints along the structure is shown by Fig. 110, and Figs. 112 and 113 show the details of their construction. The difficulty of planing the bearing surfaces to compensate for grade was overcome by the introduction of the half-pin. The bearing is on the round of this



Transverse Section Showing Bent No.13. Longitudinal Section of Tower No.13-14. Transverse Section Showing Bent No.14.

FIG. 115. DETAILS OF VIADUCT TOWERS FLANKING 168½-FT. ARCH SPAN.

pin and automatically takes up the variations of grade. The double bent tower construction which is employed throughout the viaduct, except as noted above, is shown by Fig. 114, the drawings of which leave little to be explained. It will be noted that the tower is stiff-braced throughout.

The arch over Manhattan St. is a three-ribbed parabolic braced arch of 168.5 ft. span, and is flanked at each end by a double bent viaduct tower. Each tower bent has three legs and is otherwise constructed as shown by Fig. 115. These drawings show the arrangement of the moving stairs of the "escalator" type, by which access is had to the station platforms located on top of the arch. The arch structure proper is shown in elevation and plan by Fig. 116. Each rib is divided into 14 equal panels, and from each panel point a vertical post rises to carry the floor system. Fig. 117 is a half-transverse section at the fourth panel point from the south end. Fig. 117 shows the details of one of the outside ribs of the arch.

FOUNDATIONS.—The foundations for the viaduct structure proper call for brief mention only, as they are clearly shown in several of the drawings. They were of concrete capped with granite, and were built in forms in shallow shafts opened in the street surface, and in every case were carried below the treacherous rock-fill with which the street grades of the valley have been somewhat decreased. The arch foundations deserve further mention. They are shown in diagram plan by Fig. 118. As will be seen two parallel rows of three piers each were erected. The front and rear piers were connected by masonry cores and similar cores connected the three front piers. The front piers carry the skewback stones and are the only parts of the masonry which appear above ground. It will be observed that the transverse cores between the skewback piers were reinforced with expanded metal. These arch foundations were carried down 30 ft. below the street surface to a coarse gravel and sand below the invert of a very large and deep sewer in Manhattan St. The large piers at the end of the viaduct structure were masonry on a concrete footing and were carried down to solid rock.

ERECTION.—The erection of the viaduct was considerably inconvenienced by the delay in the delivery of steel. The normal mode of procedure would have been to erect the plate girder spans first and then to proceed from one or both ends with the viaduct erection. This, however, was not possible on account of delay in building the abutment. The contractars, therefore, began at the north end of the viaduct by erecting one span of viaduct from the ground, using a fixed derrick for handling the material. A traveler with a 65-ft. boom was then erected on the completed span and employed for erecting the succeeding spans by moving ahead from span to span in the usual manner familiar to engineers, until the arch span was reached. The traveler was then dismounted and transferred to the south end of the work where a span of viaduct had been erected by derrick from the ground to receive it. Erection from the south then proceeded until the arch span was reached. To erect the six ribs of the arch span this traveler was maintained on the tower at the south end of the arch, and on the opposite north tower one of the derricks was erected. The arch ribs were shipped in four sections. The two sections for each opposite half rib were connected up on the ground, and the first two half ribs thus formed were swung forward by the traveler and the opposite derrick and set on the shoes and connected at the center. This rib was then guyed east and west by cables to deadmen. The second and succeeding arch ribs were similarly erected and guyed, except the last, which could be supported without guys. The laterals were then placed and the posts and roadway erected by the traveler and derrick moving forward from opposite ends, as the occasion demanded.

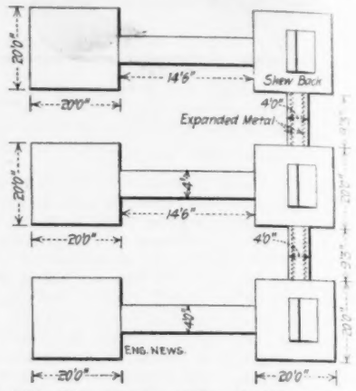


Fig. 118. Diagram Plan of Foundations for 168½-ft. Arch Span.

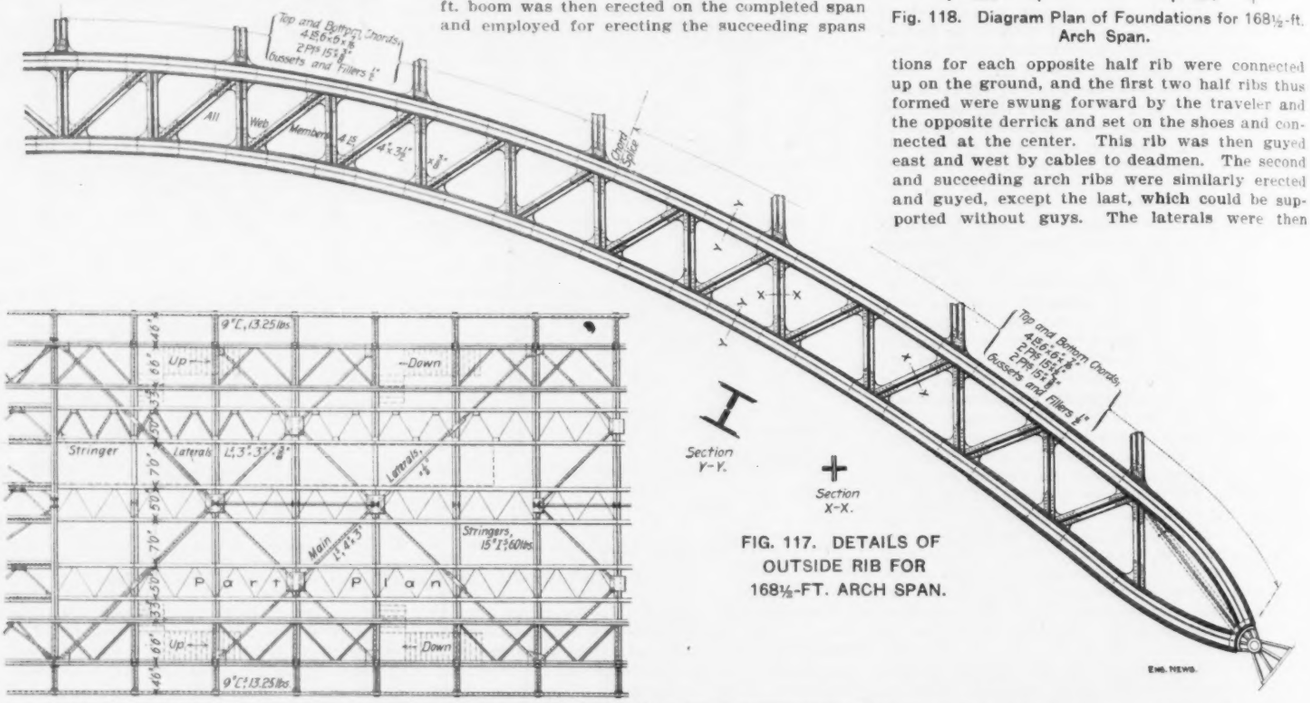


FIG. 117. DETAILS OF OUTSIDE RIB FOR 168½-FT. ARCH SPAN.

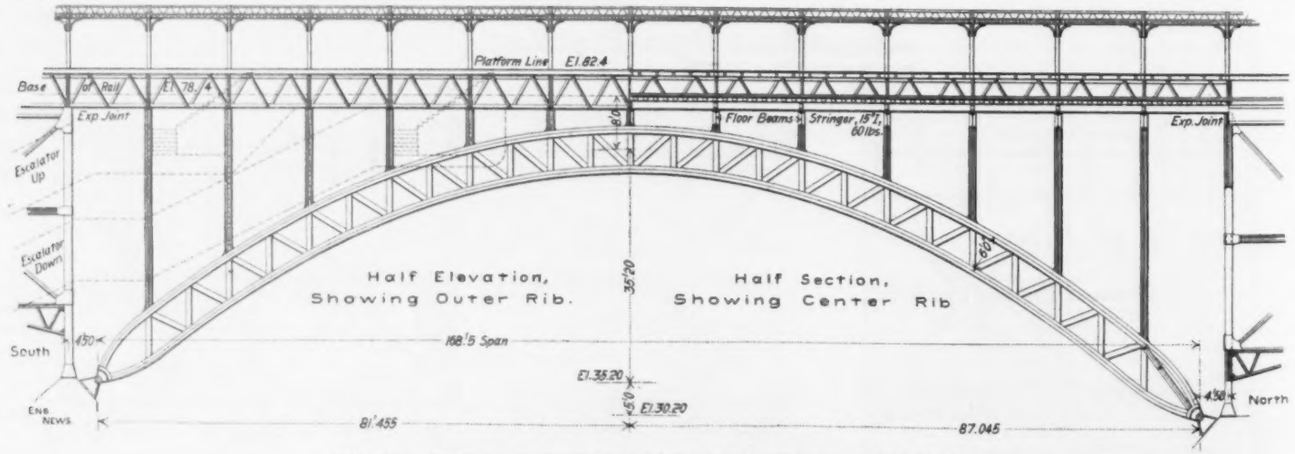


FIG. 116. GENERAL ELEVATION AND PLAN OF 168½-FT. ARCH SPAN.

The construction of Contract Section XII. came under the direction of Mr. Eugene Klapp, Division Engineer, Rapid Transit Commission.

A NEW WESTINGHOUSE HORIZONTAL GAS ENGINE.

As most of our readers are aware the Westinghouse Machine Co. of Pittsburg, Pa., has for some years been building vertical gas engines of the three-cylinder single acting type, and has made a specialty of machines of large size. Recently it has developed a horizontal double-acting gas engine which it is now placing on the market in sizes from 250 to 1,500 HP.

Two styles of this engine have been designed, one a single-crank engine, similar in its general lines to a tandem compound steam engine; the other a double-crank engine, similar to a double tandem compound steam engine, the flywheel being in the center. The engine is of the four-stroke cycle type, one stroke drawing in the explosive mixture of gas and air, the return stroke compressing it, the third stroke developing power by the expansion of the exploded mixture, and the fourth, return stroke, expelling the products of combustion. As each crank has two double acting cylinders, mounted tandem, connected to it, it is evident that the crank receives two impulses during each revolution.

A notable feature in the design of the engine is the use of hollow pistons with internal water circulation for cooling. The water supply enters a cavity on the cross-head by means of a flexible pipe connection provided with special swinging joints. It then flows through the hollow piston rod to the front and rear pistons, through which it circulates, finally emerging through a bronze tail rod extending through the rear head and there emptying into a cast-iron jacket communicating with the hot water return pipe. By thus cooling the pistons, close fits between the piston and the cylinder are possible.

The valve gear is of the cam and roller type similar to that used in the Westinghouse vertical engines. It is driven by helical gearing from the main shaft. The valves are vertical lifting poppet valves, held to their seats by springs. Each valve is independent and may be removed with its seat and liner for inspection or replacement without interference with any other part.

The mixture of gas and air takes place before reaching the valves and the proportions of the mixture are under control of the attendant. Governing is effected by varying the quantity of explosive mixture admitted to the cylinder at each stroke.

Engines of this type are now being installed at the works of the Consolidated Industries Co., at Batavia, N. Y., and at the Atlantic Refining Works in Philadelphia.

COST OF DIAMOND DRILLING IN NATAL.

Realizing that capitalists can best be induced to undertake mining where something is definitely known regarding geological formations, the Colony of Natal, South Africa, has sunk 46 diamond drill holes, or a title of 8,423 ft. of holes, in the last three years.

Mr. C. T. Gray, Inspector of Mines of the Colony, has recently made a report, an abstract of which appears in the Oct. 24 issue of the "Iron and Coal Trades Review" (London), which we give in part as follows:

Steam diamond drills:	1899.	1900.	1901.
Number of holes	5	1	17
Average depth of hole in ft.	320	294	198
Hand diamond drills:			
Number of holes	8	4	11
Average depth, ft.	107	123	151
Hand chisel drills:			
Number of holes	..	..	10
Average depth	..	..	58

In 1901 coal was discovered in veins 2 ft. or more thick by 14 of the 38 holes sunk. Including first cost of plant and all other expenditures the Government has expended about $29,460 in the three years; the war having considerably reduced the intended expenditures. Unfortunately the rate of wages paid is not given, but the other items of cost may be of more value and follow:

	1899.	1900.	1901.
Wages, rations, etc.	$3,367	$896	$7,444
Moving	104	192	719
Fuel and oil	361	68	640
Repairs	63	59	130
Diamonds	429	218	2,829
Total cost	$4,324	$1,433	$11,762
Feet drilled, hand and steam	2,607	788	5,608
Cost per ft.	$1.74	$1.81	$2.10

Since the expenditures for these three years as tabulated total $27,519, it appears that about $2,000 must have been spent for plant and general expenses.

THE NEW YORK WATER STORAGE COMMISSION, whose report was abstracted in our issue of Jan. 29, is continued by a bill now before the state legislature. The bill provides for river and stream regulation under the direction of the commission, and at the expense of the beneficiaries. Individuals or corporations possessing riparian rights on any water course, and desirous of regulating the flow therein, or municipal officials who deem regulation essential to the public health or safety, may petition the commission for regulation works. In case the commission decides that the water course in question is of sufficient importance to come within the scope of the act, and that the proposed regulation is essential to the public health and safety, it must next determine by investigation what regulation works are necessary, estimate their cost, and set forth the proportion of the cost which should be borne by the several municipalities to be benefited. Hearings must then be held, and if the commission thereafter decides in favor of the improvement it will proceed to let contracts for the same. After all the costs, including land damages as well as construction, have been determined the commission must decide what proportion, if any, shall be borne by the state of New York, which determination will be subject to approval by the governor. The balance is to be apportioned among the several municipalities benefited, subject to alteration after a public hearing. The assessors of the several municipalities, in turn, are to apportion the respective amounts among the various parcels of land benefited, whereupon, after formal hearings and final approval, they become a lien second only to the general taxes on real estate. The maintenance of river improvements made under the act is to devolve upon the commission, and the cost of the same is to be assessed upon the several beneficiaries. The citizen members of the commission are to be paid their expenses and a per diem allowance, to be fixed by the ex-officio members of the commission. The citizen members of the original commission, perpetuated by the act, were: Prof. Olin H. Landreth, M. Am. Soc. C. E., Schenectady; Elnathan Sweet (deceased); Geo. W. Rafter, M. Am. Soc. C. E., Rochester; John L. King, Syracuse; Geo. R. Finch, Glens Falls. The ex-officio members include, among others, Mr. E. A. Bond, M. Am. Soc. C. E., State Engineer of New York. The cost of the improvements would be met by 4% state bonds, payable in not more than 50 annual installments.

THE NUMERICAL CLASSIFICATION for locomotives devised by Mr. F. M. Whyte, Mechanical Engineer, New York Central & Hudson River R. R., as a substitute for the present classification by special names, such as "Mogul," "Consolidation," and "Decapod," has been officially adopted by the American Locomotive Co. In this new classification a "consolidation" engine having a pair of leading wheels, eight drivers and no trailing wheels, will be known as a "280 engine"—the first numeral giving the number of leading wheels; the second giving the number of driving wheels, and the third giving the number of trailing wheels. The system is universally applicable and only three numerals are required for any type of engine.

THE LONGEST RAILROAD TANGENT in the world is said by Mr. E. L. Corthell, in a lecture upon Argentine, to be located on the Pacific Railroad of Argentine, between Junin and La Cautiva. Its length is 186 miles.

THE AMERICAN WAVE MOTOR COMPANY has been incorporated in Delaware, and its first plant is to be located at Atlantic City. According to the daily papers, the inventor, Dr. D. K. Bryson, of Pittsburg, plans to furnish power to operate trolley lines, lights, etc.

The first demonstration plant will be installed to light one of the piers. The invention consists of long buoys placed out from shore, the first to be anchored in a depth not exceeding 8 ft. of water. The other buoys will be situated at rectangular intervals. These buoys by being thrown about by the waves in ordinary weather are said to develop 150 HP., and when a good sea is on their power of generating will be doubled.

Query: What is to be the horse-power when the waves are conspicuous by their absence?

THE ELECTRIC TRANSMISSION LINE from Shawinigan Falls to Montreal, Can., crosses the Ottawa River by two spans of aerial cable. The spans are 1,200 and 1,850 ft., respectively, the central support being a tower on an island in the river. The cables are of steel, three in number, each about 1 in. in diameter. The transmission line itself consists of three aluminum cables, each composed of seven No. 6 B. & S. gage wires. The three cables are strung on a single line of poles, one at the tip of the pole, and the others at the ends of a crossarm, so that they occupy the corners of an equilateral triangle about 5 ft. on a side. The lowest point of the cables is about 25 ft. above the ground. Poles 35 ft. long are used spaced 100 ft. apart. The line is about 84 miles long, and carries current at 50,000 volts.

THE NEW PLANS FOR THE MANHATTAN BRIDGE ACROSS THE EAST RIVER AT NEW YORK CITY.

An ordinance authorizing the construction of a third bridge across the East River, between Manhattan and Brooklyn, New York city, was passed by the Municipal Assembly on Dec. 30, 1899, and was signed by the Mayor on Jan. 8, 1900. This bridge, according to a resolution adopted by the Board of Public Improvements on Dec. 6, 1899, was to run from a point on Canal St. in Manhattan, between Forsyth and Chrystie Sts., to a point in Brooklyn between the foot of Adams and the foot of Washington Sts. Shortly after the work was decided upon by the Municipal Assembly, the Bureau of Estimate and Apportionment authorized an issue of bonds, amounting to $1,000,000, with which to begin work. The necessary engineering studies were began at once and reached a point where on March 11, 1900, bids were asked for constructing the Brooklyn tower foundations. The bridge which was planned was a suspension bridge with four wire cables carried over steel framework towers resting on masonry pedestals. The principal dimensions of the structure were as follows:

Total length between terminals	9,335 ft.
Length of center span	1,465 "
Length of shore spans, each	850 "
Width over all	120 "
Height of towers to cable center	325 "
Clear height above water at center	135 "
Number of cables	4
Diameter of cables (approximate)	19 ins.

Capacity: 4 trolley tracks; 2 elevated railway tracks; one 36-ft. roadway; 2 sidewalks.

Mr. R. S. Buck, M. Am. Soc. C. E., was Chief Engineer of the bridge and under him, subject to the direction of Mr. John F. Shea, Commissioner of Bridges, all plans and designs were prepared. On Jan. 1, 1902, Mr. Gustav Lindenthal, M. Am. Soc. C. E., became Commissioner of Bridges and shortly afterward Mr. Buck resigned from his position, and the engineering work on the bridge was assumed by the new Commissioner. In his semi-annual report (Eng. News, Aug. 21, 1902), dated June 30, 1902, Mr. Lindenthal announced that important changes had been made in the original plans. These changes involved no material alteration in the tower foundations, but they modified the design materially in other respects.

The characteristic features of the new designs for the Manhattan Bridge are shown by Figs. 1, 2 and 3. This bridge now under construction is located on a line beginning near the intersection of the Bowery and Canal St., crossing the East River at Pike Slip in the Borough of Manhattan, and reaching the Borough of Brooklyn at the foot of Washington St., and ending at Fulton St. of the same borough. It is located between the present Brooklyn Bridge and the Williamsburg Bridge, now nearing completion, and will connect the Borough of Manhattan with the Borough of Brooklyn. The bridge crosses the East River in one span and its height above high water over the navigable channels is fixed by the United States Government at 135 ft. The main structure consists of one main or river span and two side or land spans of equal length, the whole structure being symmetrical to the middle of the main span. The length of the main structure is as follows:

River span	1,470 ft.
Two land spans, 725 ft. each	1,450 "
Total length of main structure	2,920 "
Total length of the bridge structure, including approaches	9,900 "

The bridge and approaches will be the longest city bridge in the world. The grade of the bridge structure is 3 1-10% rising from each end. The superstructure of the bridge is made up of four chains of eye-bars properly stiffened and braced from which the floor system is suspended. These chains have their ends anchored in masonry anchorages and are supported by two steel towers 1,470 ft. apart and rising to a height of 400 ft. above high water. The chains are spaced 27 ft., 40 ft. and 27 ft. apart, and brackets projecting out on both sides of the bridge carry the promenade and make the total width of the bridge 122 ft.

The capacity of the bridge is as follows: On the lower deck: (1) One roadway 35 ft. 6 ins. between guard rails. The roadway will be wide enough to permit four three-horse teams to pass abreast. There are no braces or girders of any kind above

the roadway, making it free from occasional drippings or icicles. (2) Four trolley tracks, two on each side of the roadway, and completely separated from it. (3) Two promenades, 11 ft. 9 ins. each carried by brackets on each side of the bridge and affording a clear view of the river. On the upper deck: (4) Four elevated railway tracks located in pairs between the outside chains.

as the promenades, will be likewise of non-combustible material.

The type of structure used for the main span, it is considered, has many advantages: The chains and the stiffening trusses form one framework with positive and definite attachments. The form of truss is such that the greatest resistance is offered where it is most needed, the truss being

being completed. It has a main span of about 1,050 ft. He also thinks that the general design is such as to secure architectural beauty of outline, as well as engineering merit, and combines the desirable elements of utility, beauty and economy with great rigidity, strength and permanence.

The plans for the new Manhattan Bridge, as described, have been ordered submitted to a board

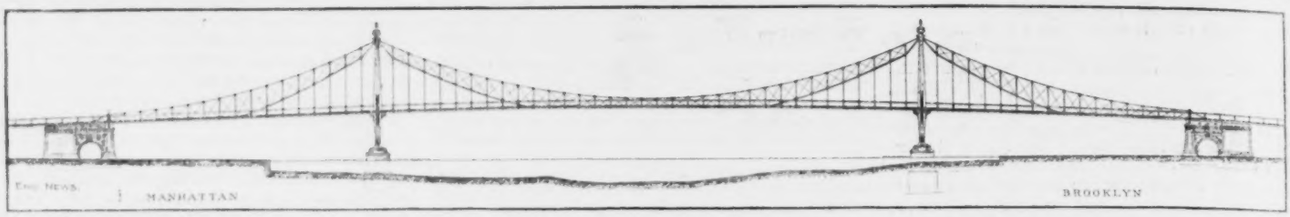


FIG. 1. DIAGRAM ELEVATION OF MANHATTAN BRIDGE, NEW YORK CITY.

Stairways are provided at several points of the bridge to take the passengers to the promenade in case of accidents to the elevated railway cars on the upper deck. The eight tracks across the bridge are estimated to have a capacity of 200,000,000 passengers per year under ordinary conditions of traffic. At each of the two anchorages stairways for foot passengers and four passenger elevators are provided for. So are also public comfort stations and a large hall available for

shallow enough at the center to cause small temperature and deflection stresses, and deep enough at the quarter points to resist well the load stresses. The form of trusses used will result in a considerable economy in metal. Owing to the great weight of the structure, this bridge will be one of the stiffest suspension bridges built. By the rigid attachment of the chains to the towers, the behavior of the bridge is made independent of any reliance on friction devices, and the action of the

of five engineers by Mayor Low. The members of this Board, as selected by the Mayor, are: Lieut.-Col. Charles W. Raymond, U. S. Engineer Corps, Mr. Geo. S. Morison, Mr. C. C. Schneider, Mr. Henry W. Hodge, and Prof. Mansfield Merriman, all Members Am. Soc. C. E. The questions upon which the Board is desired to pass are:

(1) Are the plans in accordance with advanced knowledge of suspension bridge designing, with a view to economy of construction, provision for temperature stresses, rigidity under concentrated loads, and resistance

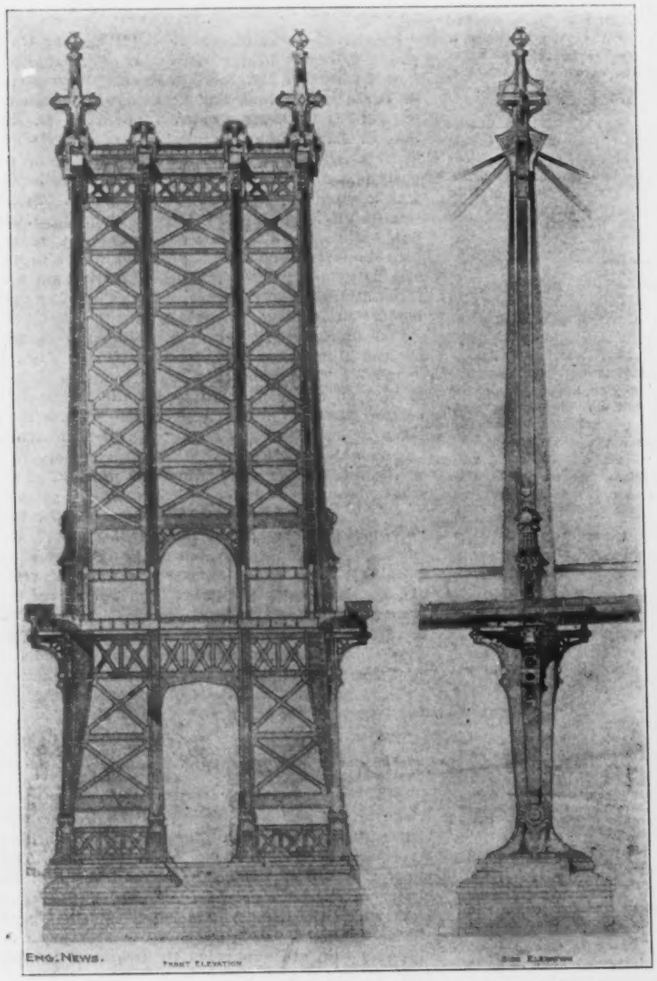


FIG. 2. FRONT AND SIDE ELEVATIONS OF HINGED TOWER FOR MANHATTAN BRIDGE.

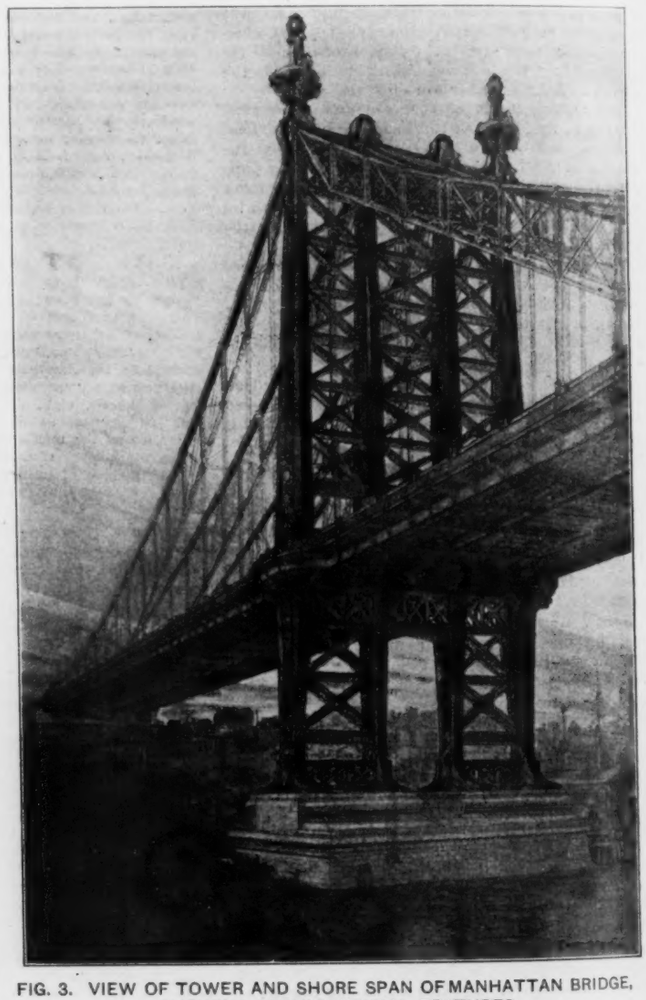


FIG. 3. VIEW OF TOWER AND SHORE SPAN OF MANHATTAN BRIDGE, SHOWING ARCHITECTURAL FEATURES.

public meetings and the like. The bridge will, therefore, be accessible to passengers also at Cherry and Pike Sts., in Manhattan, and Water and Adams Sts. in Brooklyn. The structure will be fireproof throughout. The roadway will have a foundation of steel buckle plates; and the track foundations for the eight lines of railway, as well

bridge under load will be like that of an elastic body. Finally, the eye-bar links used for the chain make this type especially well suited for speedy erection. It is also pointed out by Mr. Lindenthal that a recent instance of a long-span suspension bridge built of eye-bar links is the Buda-Pesth Suspension Bridge, in Austria, now

to wind pressure; also as regards quality of steel and its protection against corrosion?

(2) Will the strength, stability and carrying capacity of the bridge be adequate for any congestion of traffic that may occur on the railroad tracks, roadways and promenades?

(3) Will the structure, as designed, be fireproof?

(4) Do the plans permit of speedy erection of the superstructure, after the completion of the anchorages and tower foundations?